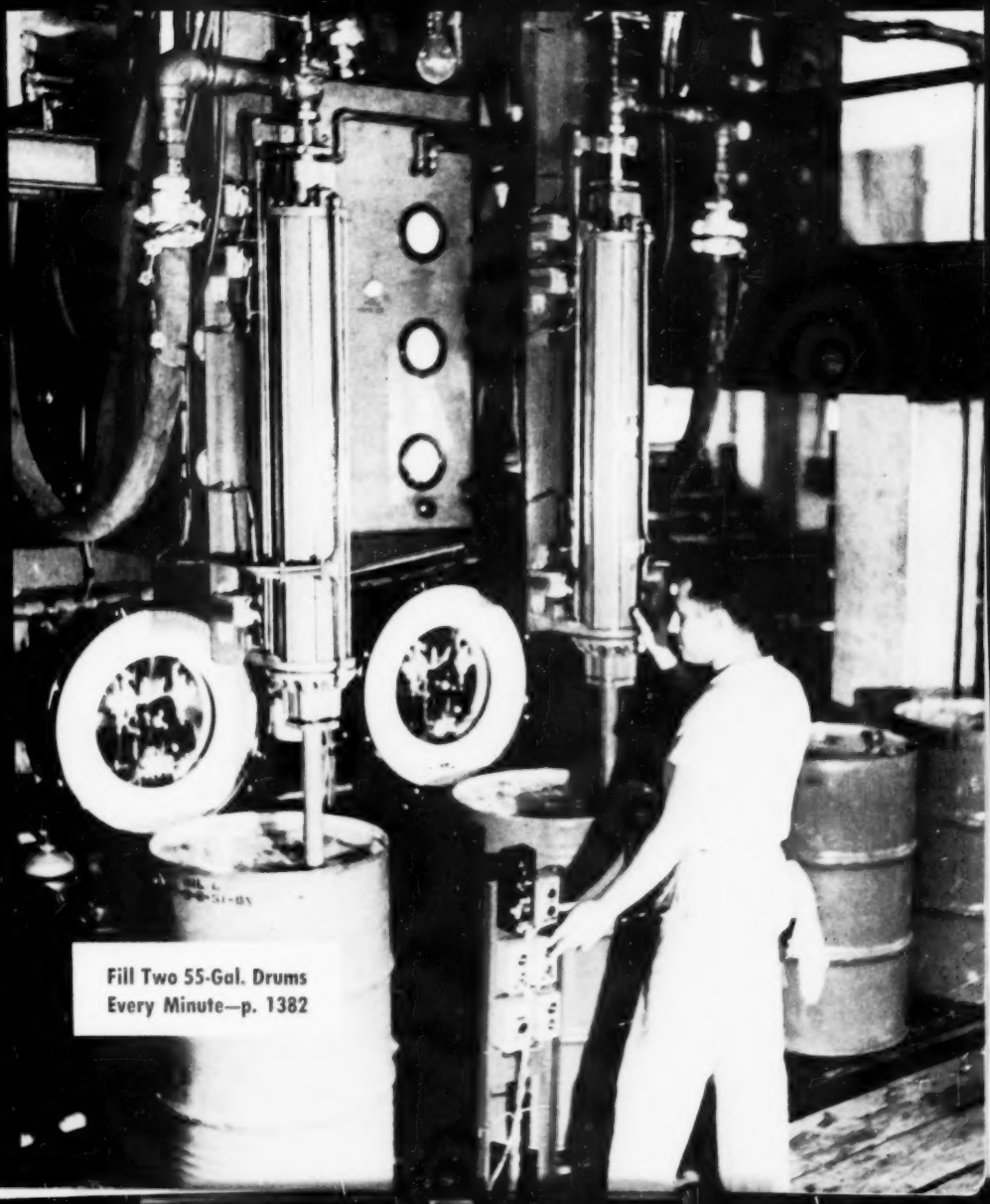
DECEMBER, 1951
VOL. 6, NO. 12

# PETROLEUM PROCESSING



Fill Two 55-Gal. Drums Every Minute—p. 1382

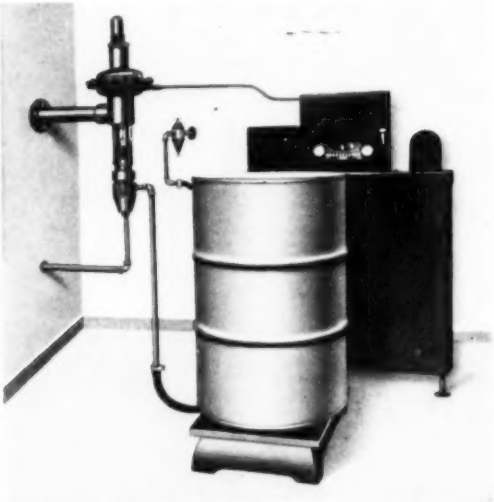
# FEED PETROLEUM CHEMICALS *Continuously- Automatically- Accurately-*

## BY WEIGHT !

**%Proportioneers, Inc.%** new Weight-O-Matic Scale offers the petroleum industry a simplified yet accurate method for feeding petroleum chemicals by weight in continuous process applications — either at constant rates or in response to process variables. Rates of feed are infinitely adjustable, from a few ounces to many pounds per minute. The treating chemicals may be injected into vacuum or pressure without affecting performance. This new scale comes in a wide range of capacities and uses the %Proportioneers% Loss-in-Weight principle. It may be equipped for automatic rebalancing and reloading and two Weight-O-Matics may be used in parallel for uninterrupted feeding.

The Weight-O-Matic is ideally adapted for use in the laboratory or full scale plant production. Units can be supplied for feeding gases, liquids, or slurries. The scale tank can be pressurized or an eductor or gravity feed can be employed for discharging into flowing streams. Because the Weight-O-Matic responds only to weight demand, no correction factors for temperature changes need be applied. Volumetric calibration is also unnecessary. The feed is smooth, continuous, and without pulsation.

The Weight-O-Matic may be equipped with totalizers, recorders, and other accessories. The basic unit contains an alarm circuit which may be connected to a visible or audible alarm system to warn the operator of over- or under-feeding and inform him when the treating chemical reaches minimum and recharging is required.



%Proportioneers% Weight-O-Matic drum size automatic scale for loads up to 1,000 lbs. gross.

### APPLICATIONS

The Weight-O-Matic, used in finished product blending, handles all additives commonly used in the petroleum industry:

**GASOLINE**

Dyes, inhibitors, anti-oxidants, metal deactivators, etc.

**LUBE OIL**

Dyes, inhibitors, anti-foamers, perfumes, V.I. improvers, etc.

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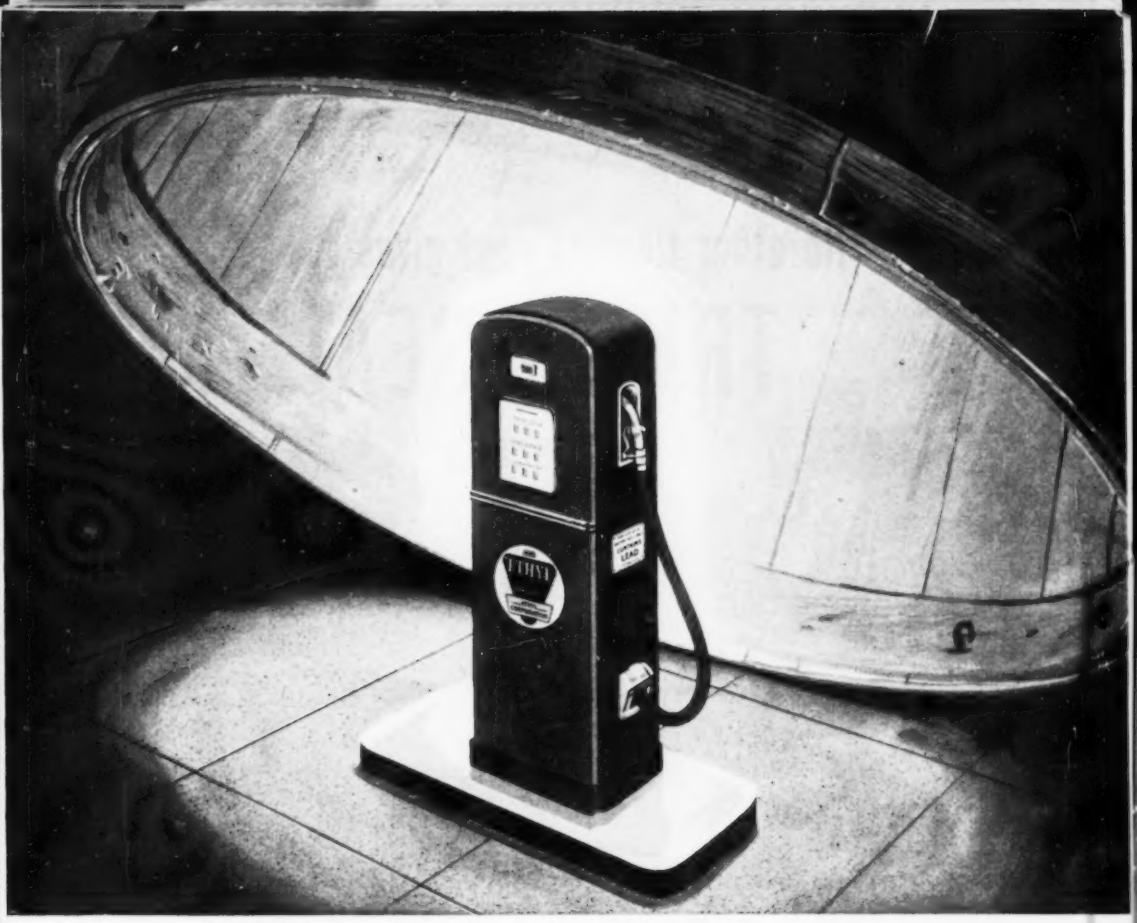
Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.




# We don't hide *your* light under a bushel

We don't believe in keeping the facts about your best gasoline a secret.

For twenty-seven years Ethyl advertising has been telling car owners what your best gasoline will do for them. Starting in 1924, Ethyl advertising and promotion helped establish the premium market—a market which has brought millions of dollars of added income annually to the petroleum industry.

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This year is no exception.

Ethyl's "powerful difference" campaign is appearing in national magazines reaching more than 56,000,000 readers monthly. And during the peak driving season, television and special drive-in movie films demonstrate why it's smart to use premium gasoline. Day in and day out Ethyl advertising is making car owners conscious of top-quality gasoline—helping you and your dealers sell quality products.

**ETHYL CORPORATION . . . New York 17, New York**

No other floating roof gives you . . .

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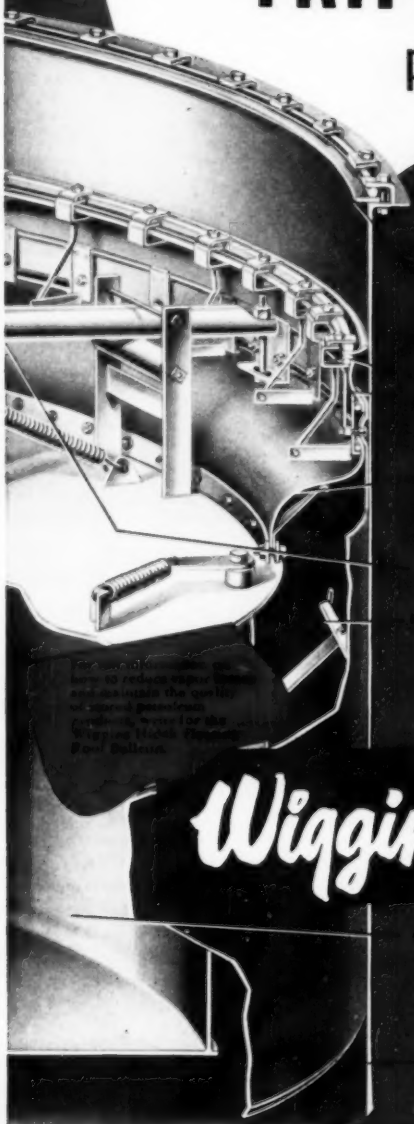

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The weekly oil marketing magazine, covering news prices, transportation, storage, merchandising

**Platt's Oilgram News and Platt's Oilgram Prices**
A daily independent oil-news and oil-price reporting service issued from New York, Cleveland, Houston

December, 1951
Vol. 6, No. 12


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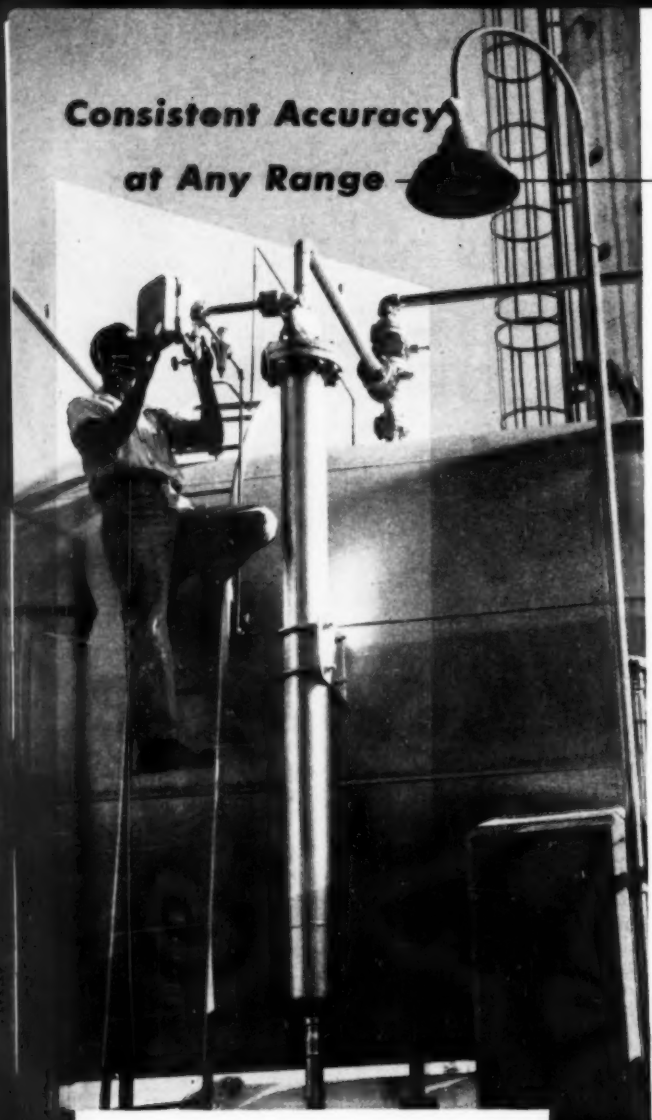


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## LIQUID LEVEL CONTROL

### TYPE 888

Any level control is accurate when first set—but BS&B's new Climax Type 888 Liquid Level Controls are **consistently** accurate! Whether the liquid level range is ¼" or 120"—the CONE PIVOT suspension point of the new Climax 888 is friction free—largely self-compensating for misalignment—does away with the sticking action of outboard bearings or the climbing of knife edges.

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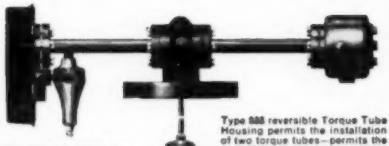
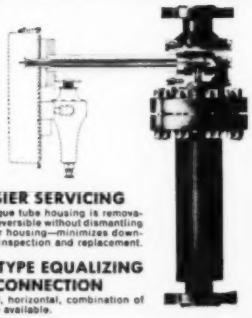
TYPE 888 TORQUE TUBE is stronger, heavier and made of INCONEL—the material found most corrosion resistant under torsion stresses. (Other alloys available in stock for special conditions.) The torque tube shaft is rigidly centered by a friction-free ball bearing.

HEAVY TORQUE TUBE helps provide longer life—permits the employment of heavier displacement elements with high safety factor and wider gravity range application.



**DOUBLE DUTY with DUAL TORQUE TUBE**

Type 888 reversible Torque Tube Housing permits the installation of two torque tubes—permits the use of another pilot or switch. Thus One Type 888 Liquid Level Controller can also operate an alarm, control an electric circuit, operate two pilots, control an additional electrically operated valve in event of pneumatic supply failure or other emergency.



**EASIER SERVICING**
—the torque tube housing is removable and reversible without dismantling controller housing—minimizes downtime for inspection and replacement.

**ANY TYPE EQUALIZING CONNECTION**
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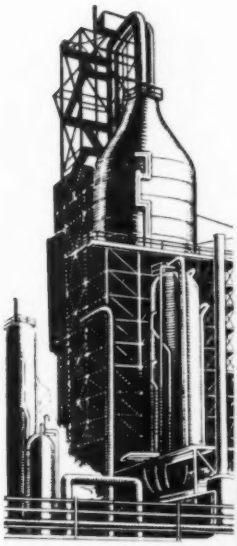
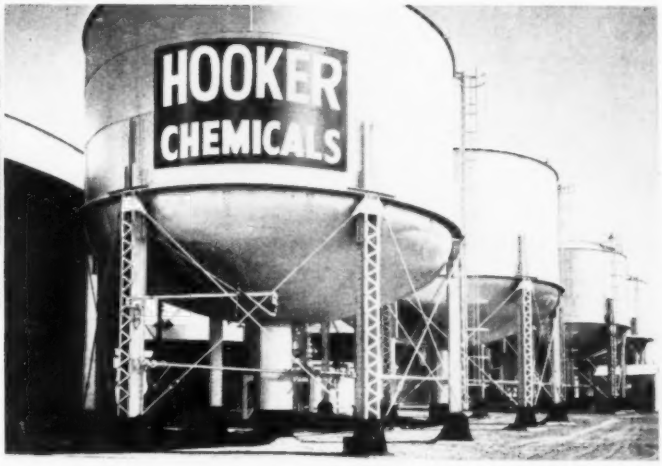
# Why Petroleum Refiners specify HOOKER






HOOKER CAUSTIC SODA distributing station at Wilmington, Calif., serves refiners in the area.

**HOOKER CHEMICALS USED BY THE OIL INDUSTRY**

| | |
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| Caustic Soda | Aluminum Chloride |
| Chlorine | Antimony Trichloride |
| Muriatic Acid | Sulfur Chlorides |

Refiners use *Hooker Caustic Soda* for sweetening base stocks, and for neutralizing chemical wastes. They specify *Hooker Chlorine* for water treatment. *Hooker Muriatic Acid* is used for treating wells to improve production.

The other Hooker Chemicals listed above find wide use as catalysts in isomerization, polymerization, and treatment of hydrocarbon oils.

**DELIVERIES**

**—Most of the Hooker Chemicals listed here are available now; some in limited quantities. Others will be available in the near future. Your Hooker sales representative will be glad to keep you posted on the current delivery situation.**

**Hooker offers your refinery:**

- exceptional purity that reduces processing headaches
- uniformity assured through rigid control methods
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- willing technical help on problems of supply
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Write today, on your business letterhead, for General Products List 100, and for Technical Data Sheets on Hooker Chemicals of particular interest to you.

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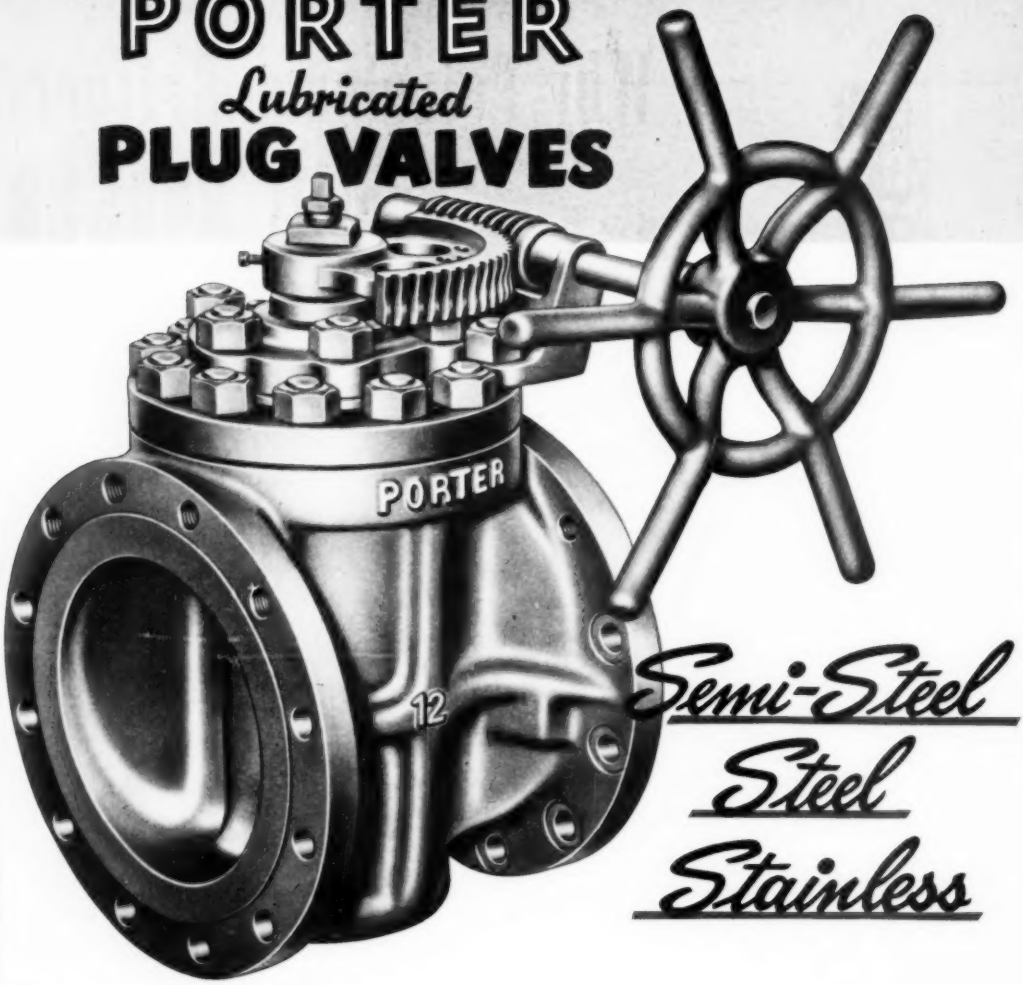
# PORTER
## *Lubricated*
## PLUG VALVES




*Semi-Steel*
*Steel*
*Stainless*

You'll get positive control and longer life from Porter Lubricated Plug valves . . . AND there are reasons.

1. **DOUBLE-SEALED PLUG STEM** — gives twice the protection against leakage.
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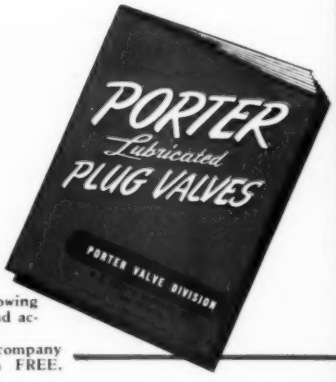
3. **GREATER FLOW AREA** — Porter design permits easy, unobstructed flow without turbulence.
4. **CONCEALED LUBRICANT GROOVES** — are never exposed to fluid handled.
5. **EASILY ADAPTABLE** — to pressure gun lubrication.

ONLY PORTER LUBRICATED PLUG VALVES HAVE ALL THESE FEATURES . . . Remember this when you buy.




**NEW** Illustrated Catalog, showing dimensions, list prices and accessories. Please request it on your company letterhead. Of course it's FREE.

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**H. K. PORTER COMPANY, INC.**

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# WHAT'S HAPPENING

**Current News Summarized For Oil Men**

## Expansion

**Standard Oil Co. (Ohio)** plans a $14,000,000 expansion program for its Toledo and Lima, Ohio, refineries. At Toledo, work will be started early next year on sulfuric acid alkylation unit, duplicate of unit now in operation. New alkylation facilities will charge 3,000 b/d of B-B feed, turning out 1,900 b/d of avgas alkylate. At Lima, company plans to install first unit using new TCR (Thermofor Catalytic Reforming) process recently developed by Socony-Vacuum, and using Sohio-developed chromia-alumina catalyst. Reformer will have charge capacity of 15,000 b/d, and estimated $8,500,000 cost will include facilities for recovery of aromatics. Also at Lima, crude capacity will be increased 5,000 to 10,000 b/d by addition of new fractionator to crude coker, which will permit coker to operate nearer top capacity.

**Shell Oil Co.** has begun a 3-year $42.5 million expansion and modernization program at its Wood River, Ill., refinery. In addition to increasing throughput from 120,000 b/d to 170,000 b/d, most of the sum will be spent replacing obsolete equipment.

**Deep Rock Oil Co.** has let contract for construction of a lube oil plant of 950 b/d finished lubes capacity at its 18,000 b/d Cushing, Okla., refinery to M. W. Kellogg Co. Engineering design has commenced and anticipated completion date is December, 1952. New unit will combine propane deasphalting with phenol solvent refining. Company will continue to produce "G" cylinder stocks in increased quantities.

**Continental Oil Co.** has awarded contract to Universal Oil Products Co. and Procon, Inc., covering the design and construction of a 6000 b/d Platforming unit at its Lake Charles, La., refinery as part of plant modernization now going on (What's Happening, June, 1951, p. 571). For aromatics manufacture a 150-220° F. coastal straight-run naphtha will be charged. For high quality motor fuel production, a 250-400° F. cut will be used. Construction will commence shortly.

**Sunland Refining Corp.**, Fresno, Calif., has received RFC loan of $246,000 to purchase a 900 b/d cracking plant and improve and install other facilities at its 3000 b/d Bakersfield refinery.

**British-American Oil Co.**, will build a $1.5 million grease plant at its Clarkson, Ont. refinery with capacity of 15 million lbs. yearly. Construction is expected to be completed in late 1952. Output, to reduce to minimum grease imported by B-A from the U. S., will include full range of automotive, industrial and aviation greases.

**Union Oil Co. of California** reports that construction of new asphalt facilities at an estimated cost of $1,650,000 is scheduled for its Oleum, Calif., refinery. Included in the estimate are heaters, tankage and air-blowing asphalt stills to replace obsolete equipment.

**Northwestern Refining Co.**, has let contact to Procon Inc., for building of new catalytic cracking and gas recovery units at its St. Paul Park, Minn., refinery. New units are part of an extensive expansion program to increase Northwestern's crude processing capacity from 8,000 to 30,000 b/d.

**Shell Oil Co.** will spend $30,000,000 to modernize its 45,000 b/d Norco, La., refinery, including crude throughput increase of 25,000 b/d, a "large, modern" catalytic cracker, and increases in alkylation and service facilities.

## Petrochemicals

**Pan-Am Southern Corp.** will produce polybutene and "propylene tetramer" at its El Dorado, Ark. refinery. The latter will be produced on former polymerization unit, now being revamped, while polybutene unit is scheduled for completion by Feb. 1, 1952. Polybutene production will exceed 2 million gal. annually—more than is currently being sold in U. S., while tetramer production will be about 3.8 million gal. annually. Tetramer unit can make high grade "poly" gasoline whenever needed. Indoil Chemical Co., like Pan-Am a subsidiary of Indiana Standard, will sell products.

**Heyden Chemical Corp.** will build a $12 million methanol-from-natural gas plant near Houston on 60-acre site between Mathieson Chemical Corp. and Phillips Petroleum Co. fertilizer plants. Construction will begin in first quarter 1952.

**Shell Chemical Corp.** now plans to build its new 150 ton/day anhydrous ammonia plant at Ventura, Calif. Unit was previously scheduled for Dominguez-Wilmington area (What's Happening, Aug. '51, p. 804).

**Standard Oil Co. of Calif.** has awarded Bechtel a $1,500,000 contract for expanding alkane plant facilities at its Richmond, Calif., refinery. This plant produces ingredients for synthetic detergent materials. New facilities are expected to increase capacity to 3000 b/d.

**Canadian Chemical Co. Ltd.**, new affiliate of Celanese Corp. of America, will produce methanol and propylene glycol, among other oxygenated chemicals, in new plant to cost "in excess of $50 million" on 430 acre site in Edmonton, Alta. New production is intended to meet "major portion" of Canadian demand with some chemicals also being exported. Chemi-

*Information on these pages is obtained through the nation-wide news coverage service of* PLATT'S OILGRAM NEWS

cals include dipropylene glycol, n-propanal, n-propanol acetate, acetone, acetaldehyde, formaldehyde, n-butanol, acetic acid and pentaerythritol.

**B. A. Shawinigan's** new phenol plant in Montreal East, Quebec, (What's Happening, Aug. '51, p. 691) will receive cumene by pipeline from British American's nearby refinery. Canadian Kellogg Co. has contract to build, and reports phenol capacity to be 13 million lbs. annually. Plant will be first of its kind to use processes licensed by Hercules Powder Co. and Distillers Ltd.

**Cooperative Farm Chemicals Assn.,** subsidiary of Consumers Cooperative Assn., of Kansas City, Mo., will build a $16,000,000 nitrogen fertilizer plant at Lawrence, Kan. Plant will use natural gas as raw material, and will turn out 110,000 tons of nitrogen products annually. Construction is expected to begin next March, with completion in late 1953.

## Natural Gasoline

**Magnolia Petroleum Co.** will build a 30,000 Mcfd. natural gasoline plant at an estimated cost of $8,400,000 in the Pegasus field of Upton and Midland counties, Texas, to recover about 105,000 gal. daily of products, including an average propane recovery of about 50%. Plant will be designed to ultimately handle 60,000 Mcfd. Completion is scheduled for Jan. 1, 1953, with construction by Hudson Engineering Corp.

Magnolia also is considering a second plant in the southeast corner of Midland County which reportedly will not be less than 60,000 Mcfd. While joint ownership is contemplated, utilized production and lease operation is unlikely.

## Markets, Prices

**The "October Lull" was offset in November** by active sales in most refining districts. Prices, with a few exceptions, were firm, and heating oils were quoted higher in markets from the Gulf to Chicago.

**Colder than normal weather** skimmed off some of the accumulations of fuel oils, particularly in the Midwest. In seaboard districts, refiners continued to find a ready market for virtually all products, partly as a result of world shortages caused by Iranian dispute. Asiatic Petroleum Corp., buying in U.S. for British account, during the month scheduled over 3 million bbls. of refined products for lifting at the Gulf during the first quarter of 1952.

**PRICE HIGHLIGHTS—At the Gulf:** kerosine quotations for cargo lots were up 0.5c to 9c; Grade 115/145 avgas up 0.5c to 17.75c, and Grade 91/96 up 1.25c to 15.75c. . . **In the Midwest:** general increases of 0.3c to 0.5c in tankwagon ceilings for heating oils were authorized by OPS; for tank car/truck transport lots, No. 2 prices were up 0.125c to 8.25c for shipments FOB Group 3, and up 0.25c to 10.5c at Chicago; at same time, gasoline quotations were off in amounts ranging from 0.125 to 0.5c in the Midwest and most Mid-Continent districts. . . **On the East Coast:** tank car and barge prices were "firm at ceilings" for most products, and soaring rates for tanker transportation from the Gulf made for closely held supplies.

**Of the specialty products,** prices for bright and cylinder oils still were strong, although a tendency toward easier prices for solvent and conventionally refined Mid-Continent neutral oils continued. Prices for Pennsylvania petrolatums and scale wax were easy, and reflected reduced export demands for these products at New York.

## Industrial Mobilization

**PAD's deputy administrator Bruce Brown** will be replaced next June 1 by J. Ed Warren, independent producer of Midland, Tex. Warren will join PAD on April 1 as assoc. deputy administrator, prior to replacing Brown. Latter plans to return to presidency of Pan-Am Southern Corp., New Orleans.

**Reservists in the petroleum industry** who have been recalled to active duty were given procedure last month on what to do if they want to "invite attention to his current assignment to other than petroleum duty, or submit a request for reclassification on the basis of his qualifications and/or experience." Rear Adm. B. B. Biggs, chief of Munitions Board's Office of Petroleum Programs, said such reservists are "authorized to address an official letter via official channels to the appropriate responsible agency listed below:

"Army—The Adjutant General, Dept. of the Army, Washington 25, D. C.

"Navy—Chief of Naval Personnel, Navy Dept., Washington 25, D.C.

"Air Force—Director of Military Personnel, U. S. Air Force, Washington 25, D.C."

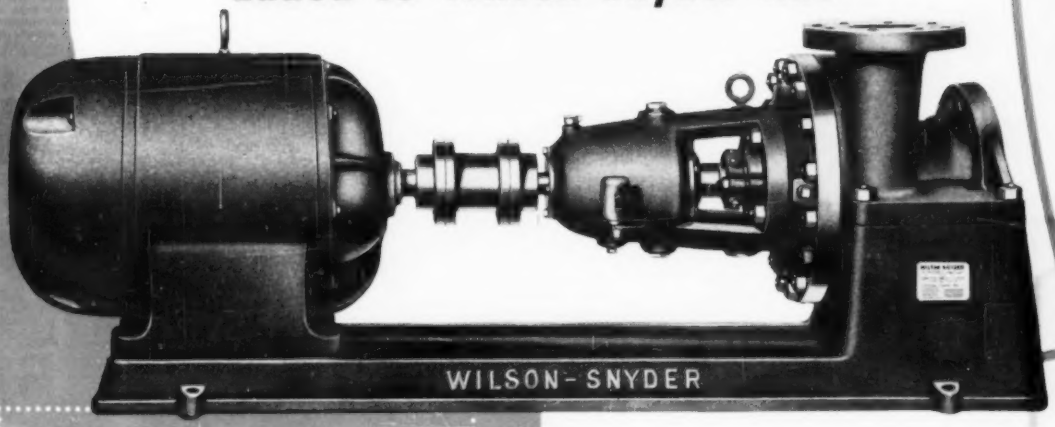
**Steel and aluminum supply picture** should brighten after 1st half of 1952, according to Defense Mobilizer Charles E. Wilson. Until then, situation will continue tight, but new production facilities are expected to start filling the gap in last half of year —unless military demands rise unexpectedly.

**Nickel shortage is getting worse,** according to National Production Authority, because of mounting requirements for high nickel-bearing alloys for jet aircraft and other defense production needs. If situation worsens, NPA may expand current list of prohibited uses of Schedule A of M-80.

**Adequate hydrofluoric acid supplies** for avgas manufacture are forecast by PAD. National Production Authority plans to limit some uses of HF acid, now in short supply because of shortages of two main raw materials—fluorspar and sulfuric acid, but PAD does not expect such limitations to affect high priority avgas program.

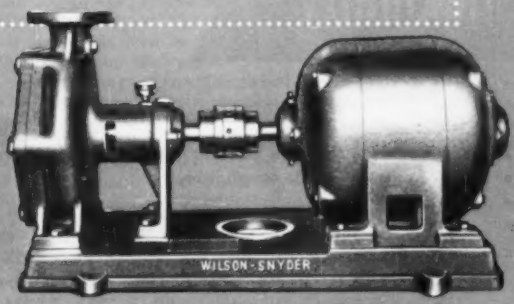
**New director of Bureau of Mines** selected last month by President Truman is John J. Forbes, 37-year veteran with Bureau and chief of its Health and Safety Division since 1948. He replaces James Boyd, who resigned recently.

# *Proven* Centrifugal Process Pumps added to Wilson-Snyder line




**TYPE ES . . . 14 sizes . . . Maximum interchangeability . . . Minimum parts inventory . . . . Capacities to 1600 GPM . . . Heads to 725 feet . . . Temperatures to 900°F. . . . Suction pressures to 600 psi . . . Discharge pressures to 900 psi.**

**TYPE CS . . . 6 sizes . . . Maximum interchangeability . . . Minimum parts . . . Capacities to 550 GPM . . . Heads to 150 feet . . . Temperatures to 200°F. . . . Discharge pressures to 200 psi.**




## *For Refinery and Chemical Processing and General Service*

OIL WELL SUPPLY COMPANY has acquired the complete line of Type ES and CS Centrifugal Pumps formerly manufactured by National Transit Pump and Machine Company, Oil City, Pa.

These pumps are being engineered and manufactured at our Braddock, Pa., Plant as WILSON-SNYDER Type ES and Type CS Centrifugal Pumps. Genuine renewal parts for pumps of this type previously manufactured by National Transit are available from us.

***INQUIRIES . . . can be directed to your nearest "Oilwell" representative or to Wilson-Snyder at Braddock, Pa.***

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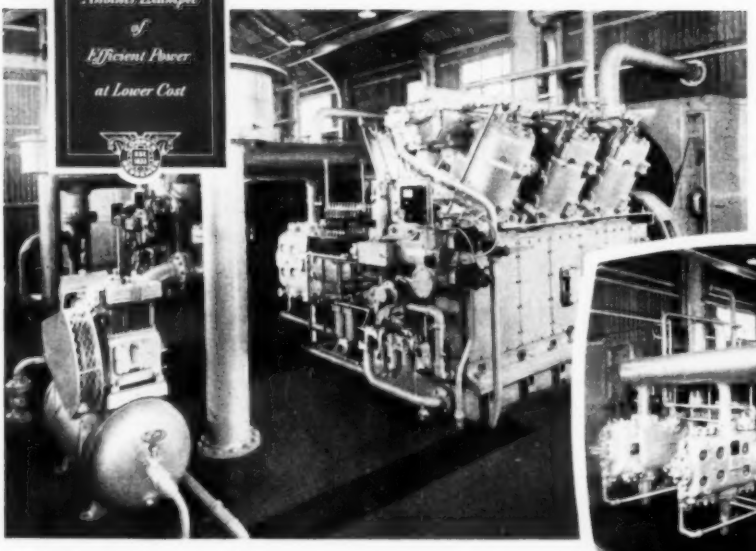

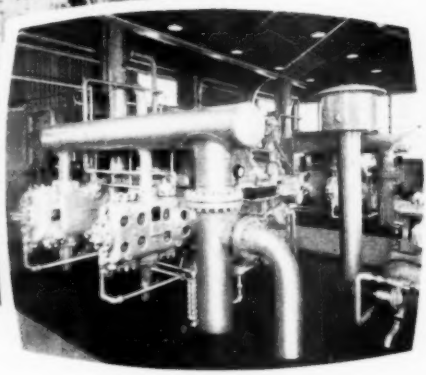

**Left:** Two Cooper-Bessemer skid-mounted GMX-6 compressors in Lone Star's Abilene Booster Station. Station is piped for either east or west delivery. Units are equipped to provide proper unloading to permit broad flexibility in meeting pressure conditions.

**Below:** Compressor cylinder side of above skid-mounted units. Floor line is flush with tops of skids resulting in conventional floor appearance and simplicity.

# GMX's at Lone Star's Abilene Booster Station

## ...2 "packages" of flexibility

IT MIGHT surprise you to know that the GMX's pictured opposite are skid-mounted units . . . 2 packages, factory tested and delivered complete with all auxiliary equipment. It's quite an advantage —made possible by the simplicity and extreme compactness of these modern Cooper-Bessemer compressors.

Secondly, and perhaps even more remarkable, is the unusual flexibility of this compressor set-up. The station is piped so that it can pump either east or west —necessitating compressors that would operate efficiently despite widely varying pressure conditions. These GMX's readily provided with the proper unloading facilities to permit such flexibility. And, with suction pressures running lower than anticipated, months on end, it's another example of how well GMX's can handle tough jobs.

If you have a compressor job coming up, tough or simple, get all the money-saving facts on modern, long-lived Cooper-Bessemer V-angles—GMX's, GMV's and GMW's. They're ready to cut your costs on any compressor requirement from 200 to 3,000 hp.

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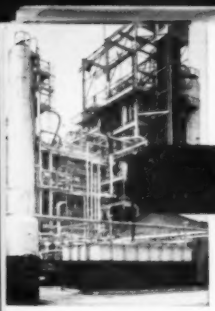


# TOMORROW... IN PETROLEUM TECHNOLOGY

**Possible Effects of Today's Developments On Future Operations**

*By the Editors of Petroleum Processing*

## Permanent Lubricants May Result From Fluorocarbon Developments

A NEW group of "fluorochemicals"—fluorine-substituted hydrocarbons in which fluorine replaces one or more hydrogen atoms without otherwise changing the structure—holds promise of developing products of high chemical stability and unusual physical properties.

Of particular interest to the oil industry are the possibilities of these fluorocarbons being used as permanent lubricants and hydraulic fluids, due particularly to their oxidation resistance and other properties. Additional products which may be affected by volume production of these new compounds include resins, solvents, refrigerants, dielectrics, and fire-extinguishing compounds.

Up to now, the big trouble in large-quantity production of fluorocarbons has been the problem of getting fluorine into the hydrocarbon molecule without (1) destroying or radically changing that molecule, or (2) involving considerable manipulative difficulties. Chemists are well aware of the violent nature of elemental fluorine and its extremely toxic nature.

The bottleneck in quantity production has apparently been broken by Minnesota Mining & Manufacturing Co. The company has recently placed on the market in semi-commercial quantities a group of fluorochemicals produced by the Simons cell, an electrolytic fluorinator. The first large-scale unit to use this device is now in operation at the firm's new Hastings, Minn. pilot plant.(1)

Big advantage of the Simons cell is that fluorination is carried out entirely in the absence of the elemental gas. The organic material to be fluorinated and anhydrous hydrogen fluoride are placed in the cell, often in the presence of inorganic fluorides and sometimes with two or more organic starting materials when operating efficiency can be improved.

Alternating iron and nickel electrodes are used, the latter being anodes. The fluorocarbon is liberated at the anode as a gas or liquid. Current density must not exceed a certain minimum value or elemental fluorine will be liberated—with disastrous consequences. By varying cell conditions as well as the organic charge, "tailored" fluorocarbons are produced.(1)

According to MM & M, saturated fluorocarbons are the most stable organic compounds known.(2) They are inert towards such reactive chemicals as sulfuric acid, permanganate solutions, acid chromate and nitric acid. They will react with sodium and potassium at 570-750° F., and in some cases with sodium dissolved in liquid ammonia. They are non-inflammable, but may crack in the presence of heat.

Physically, boiling points are similar to the hydrocarbon analogs and melting points are generally higher. The densities are greater. The most striking differences are the low refractive indices and surface tensions, both always lower than the organic analog and, as a class, the lowest known. They are insoluble in aromatic compounds, but miscible with oxygenated compounds such as ethers, and in other completely fluorinated liquids as well as some partially fluorinated hydrocarbons.

Reactive fluorochemicals, such as trifluoroacetic acid, are quite similar to their organic analogs, quite corrosive, and form esters, anhydrides, metallics salts, amides, nitriles and the like.

Fluorocarbons now available include decafluoromethane, hexafluoroethane, octafluoropropane, tetrafluoromethane, trifluoroacetic acid, heptafluorobutyric acid, perfluoropropionic acid, henicosafluorotripropylamine, pentadecafluorotriethylamine, heptadecafluorodiethylpropylamine, heptacosafluorotributylamine.

Although fluorocarbons may find a market in the field of lubricants and hydraulic fluids, it is not likely that they will make any serious inroads on the oil industry's markets very soon.

And if uses are developed to any great extent, then refiners can confidently expect a market in supplying the hydrocarbon raw materials. —D.P.T.

(1) "Flexible Fluorinator," *Chemical Week*, Nov. 3, 1951, p. 30.
(2) "Fluorochemicals," Minnesota Mining & Manufacturing Co., bulletin, summarizing properties of various fluorocarbons.

## "Chem Show" Stresses Equipment For Petrochemical Manufacturing

CHEMICAL Plants and Equipment for the Oil and Gas Industry." This direct message appearing on one of the exhibitors' booths exemplified the accent of the 23rd Exposition of Chemical Industries in New York last month, when some 400 exhibitors displayed new process equipment, materials of construction, and chemical starting materials for an estimated total of about 40,000 visitors.

This year's "Chem Show" vividly emphasized that as fast as the mushrooming petrochemical industry comes of age, the process equipment it needs will be here waiting to be used. A major portion of the displays showed products which can be expected to fit very quickly into the picture as the right thing for the job. In fact, in some cases products were probably ahead of their time—perhaps only scientific curiosities today, but with high potential for tomorrow. Some were so new that the manufacturers had only a hand-made model to show or demonstrate and, frankly, were asking as many questions as they were answering as to possible applications.

What trends in petroleum technology were indicated, particularly for refiners who may eventually get into the field of petrochemicals?

**Materials of construction** can be expected in the long run to begin to include non-metallics, as these products are improved to meet some of the more stringent operating conditions of the oil industry.

Ceramics, new glass compounds, synthetic resins and plastics can all be looked to with increasing interest. At the same time, spurred by this competition from the non-metallics makers as well as by the current critical metals situation, alloy manufacturers will continue to develop new and interestingly different alloy products. Newer alloying metals like titanium, zirconium, and tantalum—to mention a few—will bear watching.

The regular chemical manufacturers, particularly those specializing in organic compounds, can be expected to lead the way in technical know-how in the production of high purity products, including the end-chemicals from petroleum hydrocarbons which are now commonly referred to as petrochemicals.

**Equipment** designed for improved processing, and especially separation, of these high-quality end-products may be in the form of designs not altogether familiar to today's conventional refining practices. Equipment of this type, as displayed at the Chem Show, included improved fractional distillation columns with high efficiency packing as well as such newer techniques as liquid-liquid extractors, centrifuges, coalescers, and the like.

**Future of the petrochemical** industry was perhaps best summed up by A. B. Hersberger of Atlantic Refining Co.,[1] who predicted a four-fold expansion in the next 10 years. He said, in part:

"It has been estimated that currently about 25% of all chemicals produced in this country are petroleum-derived. This figure can rise to 50% during the next decade, which forecasts approximately a four-fold growth in petroleum-derived chemicals."

Mr. Hersberger pointed out that "while early growth in the industry, particularly between 1925 and 1940, was largely in the field of aliphatic chemicals, aromatics have recently become important and will represent much of the future growth in petrochemicals. Even some inorganic chemicals are produced from petroleum in important quantities, such as ammonia, sulfur, and sulfuric acid." —W.C.U.

(1) "Fourfold Expansion in Petrochemicals in 10 Years Predicted," by A. B. Hersberger, manager, chemical products section, Atlantic Refining Co., *N. Y. Journal of Commerce*, Nov. 26, 1951.

## Expanding Use of Propane Seen Aiding Turbine Fuel Problem

AIRCRAFT designers face difficult problems in developing turbine-driven airplanes because of the characteristics and costs of available fuels, it was brought out during the recent annual meeting of the California Natural Gasoline Assn. in Los Angeles, by Carlos Wood, Douglas Aircraft Co.

Flying rapidly at extreme heights and between limits of ground temperatures and the extreme cold of high altitudes makes ordinary gasolines out of the question, he pointed out, adding that equipment necessary to recompress such fuels, or to refrigerate them to prevent their boiling away, cuts seriously into the payload of the aircraft. On-the-ground refrigeration also involves many costly considerations.

The aircraft must be safe, dependable and economical in operation. Pressurizing the fuel tanks again involves the weight question, but more seriously interferes with streamlining the thin wings. Moreover, it might prove "very embarrassing" if a tank exploded in flight, or if the ship could not get off the ground with a practical payload.

Somewhat the same considerations, albeit in lesser degree, apply to present jet fuels. They evaporate and vapor recovery equipment is too heavy and bulky. There also is the bugaboo of availability, perhaps the worst current headache especially for the military.

Residual fuels and the heavy distillates offer no problem with respect to vapor pressure and evaporation. But they do bring in the subject of high pour point and pumping problems. Insulating the tanks to keep the fuel warm enough to flow and providing means of heating the plumbing so the heavy oil can be pumped to the engine again involve the complications of streamlining and added weight. Furthermore, these fuels are not as inherently "clean" as are the lighter distillates.

Of all the practical fuels now in sight, the distillates as represented by current jet fuel specifications appear as the best compromise, Mr. Wood stated, with all their shortcomings. But there is considerable competition for the fractions which go to make up JP fuels. Therefore, he concluded, the aircraft designer is strongly interested in any changes in demand for petroleum fuels which might make the distillates more readily available for turbine aircraft.

In the light of turbine aircraft designers' problems, a remark in the general sessions by T. S. Petersen, Standard Oil Co. of California president, may be quite significant. He said, in discussing further use of propane as a help in broadening the markets of the natural gasoline industry: "One possibility that is receiving considerable attention is the further use of propane in heavy duty internal combustion engines."

He added that a 20% reduction over the past 10 years in the number of plants has not prevented doubling production of liquid hydrocarbons in California during the same period.

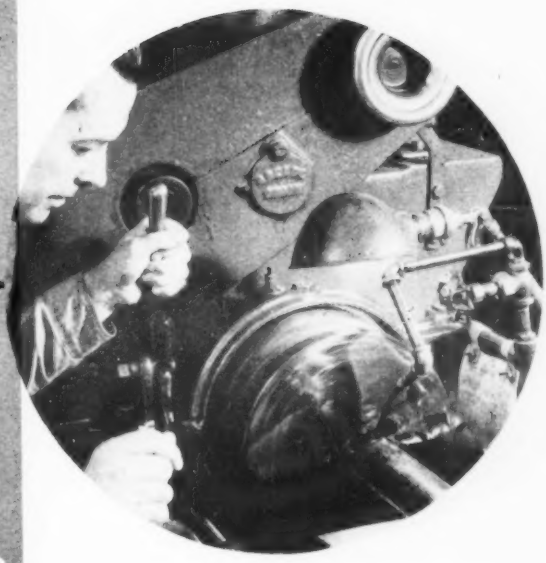
Perhaps the answer to the problem of fuel for turbine aircraft may not be so far away as Mr. Wood believes. As we reason it:

Heavy duty engines in trucks consume an enormous amount of gasoline yearly; more in summer than winter. Many additional trucks are equipped with Diesel engines, fuel for which competes both with gasoline and JP fuels for distillate fractions. As Mr. Petersen stated, conversion of spark-ignition engines are growing. Conceivably, the Diesel engines might also be converted to propane with the proper technical investigations. Indeed, some sources have reported that experiments along this latter line now are underway.

The possibility now appears that, if either or both of these conversions should come into being on any large scale, obviously there would be a corresponding decrease in demand for motor gasoline from these sources. Carrying the speculation a bit further, such a drop, if not compensated for by increased use of gasoline in passenger cars, would lessen competition for the very fractions of crude petroleum apparently most desired by designers of turbine aircraft.

Furthermore, if propane and natural gas continue to take over more and more of the home heating oil market, as several respected economists anticipate in the next several years, perhaps the availability of distillate-type turbine aircraft fuels may not be so far away, or serious, as Mr. Wood's paper pictured. —D.P.T.

# cutting oils work better



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**Typical Inspection Values for SANTOLUBE 52**

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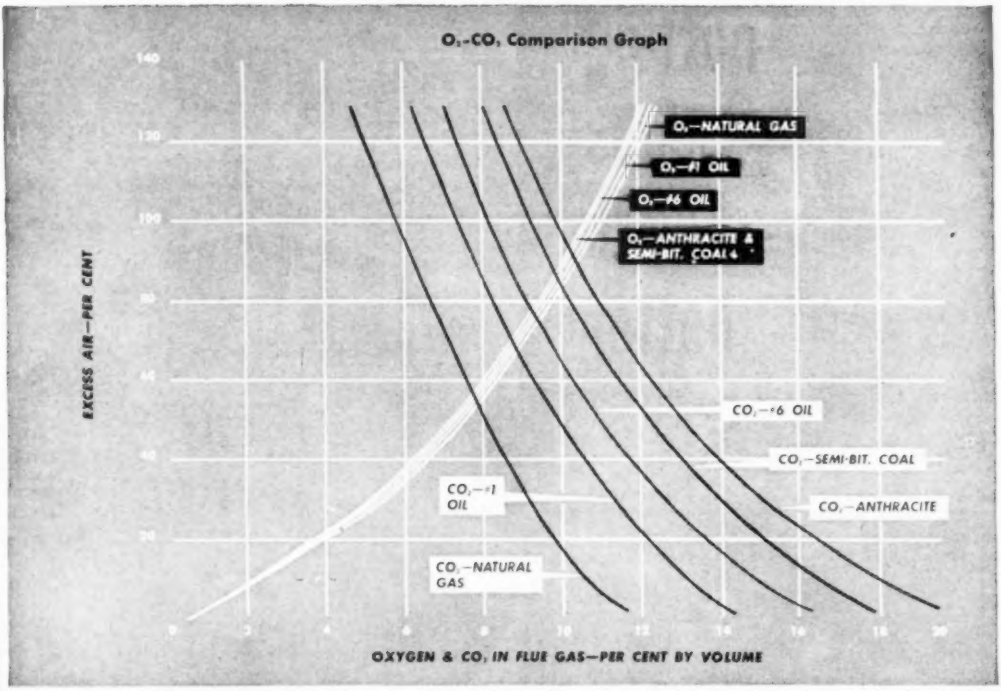
*(To obtain more data on advertised products see page 1428)*

# How to burn Multiple Fuels efficiently




***Oxygen and Oxygen alone gives you an undistorted picture of the amount of excess air present.***

When switching from one fuel to another or burning more than one fuel at the same time, you can realize large savings with a continuous indication of Oxygen content in your flue gas—because Oxygen and Oxygen alone gives you an undistorted picture of the amount of excess air present.

This fact is borne out by the graph showing the relationship of excess air to $CO_2$ and $O_2$ in the flue gas of five common fuels. While the $O_2$ curves nearly coincide (especially in the important 30% excess air range) the $CO_2$ curves diverge widely.

### Large Savings Possible

This deviation was costing a medium sized refinery in Michigan $35-40 per day in boiler room fuel costs. Burning a combination of oil and gas they found that a combustion control system to handle their multiple fuel firing conditions would cost more than their small boilers.

They purchased a Hays Magno-Therm Oxygen Recorder, and immediately found that their boiler operation was so inefficient that the pen would not stay on the 0-10% chart. However, by operating with reference to the $O_2$ recorder they were able to reduce fuel costs enough *to pay for the instrument in 40 days.*

With the Hays Magno-Therm Oxygen Recorder you get:

**Continuous, highly accurate indication and recording.**
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**Freedom from chemicals or hazardous fuel burning in the analyzing process.**
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If you are facing the problem of multiple fuel combustion, you will want a detailed copy of this $O_2$-$CO_2$ Comparison Graph as well as Hays Bulletin 50-829—describing the Magno-Therm Oxygen Recorder. Write for this free information.

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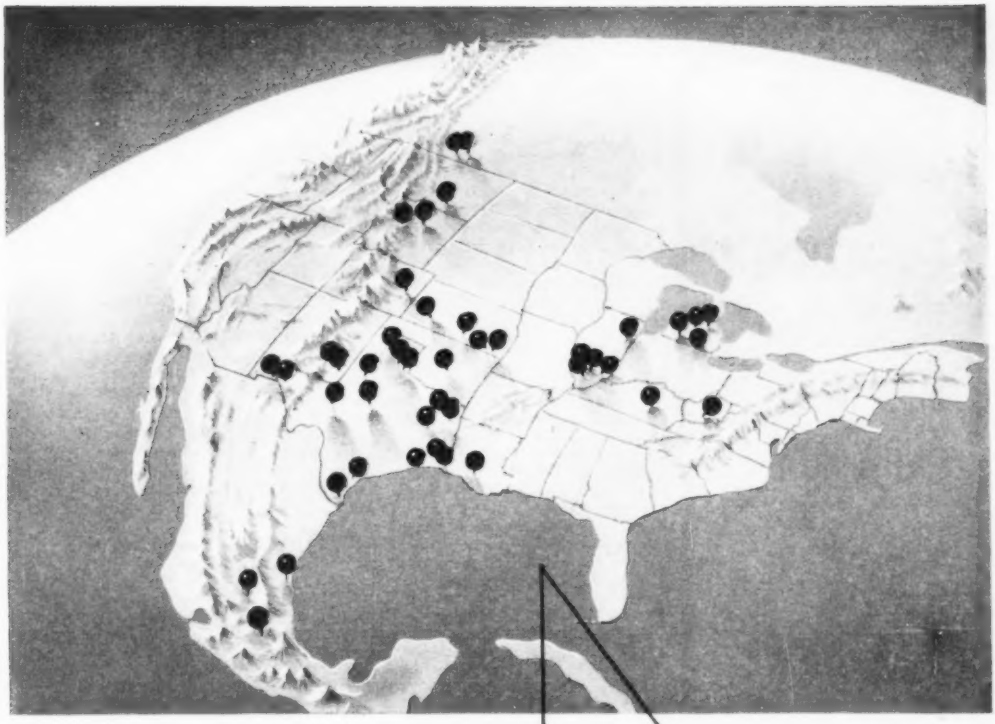

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# LETTERS

## Russian Oil

I read with considerable interest the article "Can Russia Fuel a War?" [Oct. PETROLEUM PROCESSING, p. 1116].

Unfortunately, I am in agreement with the contents of the article. Mr. M. Sittig made a very able presentation of the subject, not trying to hide any facts or make them subject to political propaganda. As far as the viewpoint of Mr. Shimkin is concerned, I have my doubts about it . . .

VLADIMIR A. KALICHEVSKY
Beaumont, Texas

• Rear Admiral M. Zacharias's statement that the Soviets are vulnerable because of the lack of oil is probably correct, except that he has not made the point clear that this applies to the offensive warfare. It is my considered opinion that with the vulnerability of a good part of their present sources of supply to air attack, they could never hope to carry on a successful offensive campaign for any length of time, particularly if the break of hostilities is delayed another 12 months.

Should, however, the Soviets revert to their habitual tactics of defensive warfare, that is defense in depth, their oil supply would be ample for a prolonged and exhausting warfare, which might eventually develop into a stalemate or negotiated peace, or even sadder consequences. It is therefore, in my opinion, not a question whether the *Soviets* can fuel a war, but whether *we* have sufficient guts and resources to deliver a rapid knock-out blow . . .

Regarding the Soviet refining technology, it is my opinion from what I could observe personally and gather subsequently, they are sadly lagging behind the U. S. As a matter of fact, most of their present refineries would be considered definitely obsolete in this country . . .

Regarding Soviet refining capacity, the figure of 880,518 b/d is, according to the information I possess, deliberately exaggerated. It is possible that the Soviets possess plants which *would* process, if operated in the U.S., this amount of crude. However, due to severe climatic conditions in the area of many of their refineries, coupled with inefficiency, poor housing conditions, under-nourishment and under-clothing of personnel, as well as clumsy and inadequate supply of spare parts, equipment and machinery, some of these refineries operate at as low as 30% of their rated capacity, hence their total actual production should not be much over their 1941 figures quoted by you [640,000 b/d]. . . .

Regarding synthetic fuels, the Soviets learned a lot from the Germans, as they were allowed to import a large amount of German top technicians, as well as dismantle and move to Soviet Russia entire German synthetic fuel plants. When we were in Sovdepia, the head of their synthetic fuel division told us that they are planning not only to duplicate Hitler's synthetic fuel industry, but substantially increase it.

This phase of the Soviet petroleum development is disturbing to me, as the German technique was excellent. . . . it is my opinion that the Soviet petroleum war potential, as compared with the United States and its Allies, is about in a ratio of 1 to 10, so that from this standpoint at least we have a very encouraging picture. .

NICHOLAS DERACHAT
Director Sales
Houdry Process Division
World Commerce Corp.
Washington, D. C.

## Takes Issue with Layouts —and He's Right

I have just finished reading the excellent article "Road Antiknock Performance of Motor Gasolines," by Alspaugh and Hall of the Ethyl Corp., which starts on page 854 of the Aug. 1951 PETROLEUM PROCESSING.

The purpose of this letter is to indicate to you my disappointment that the pleasure and profit of reading the article is decreased to a material extent by the separation of the figures from the text describing them. Of the 13 charts, more than half require the constant moving of sheets back and forth in order to look at the figures as the text is read. Why is this necessary? . . .

To a lesser extent, but equally annoying, is the placing of the first figure in the article "Aromatics by Adsorption," which constitutes the lead article in the same issue. The entire heart of this article resides in this first figure which appears on the first page of the article. The entire descriptive matter referring to the figure appears on the succeeding page, which happens to be on the other side of the sheet and requires the sheet to be moved back and forth at least half a dozen times as the reader makes an effort to tie together the text and the graphical presentation.

Your magazine is so good and I derive so much pleasure and benefit from reading it that it irks me considerably to find the arrangement between charts and text less than perfect from the reader's standpoint.

J. L. COOLEY
Vice President
California Research Corp.
San Francisco, Calif.

*Mr. Cooley's criticism is well-taken and to the point. Steps have been taken to correct the situation.*

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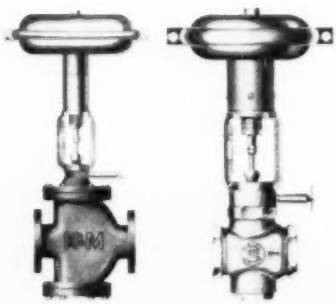
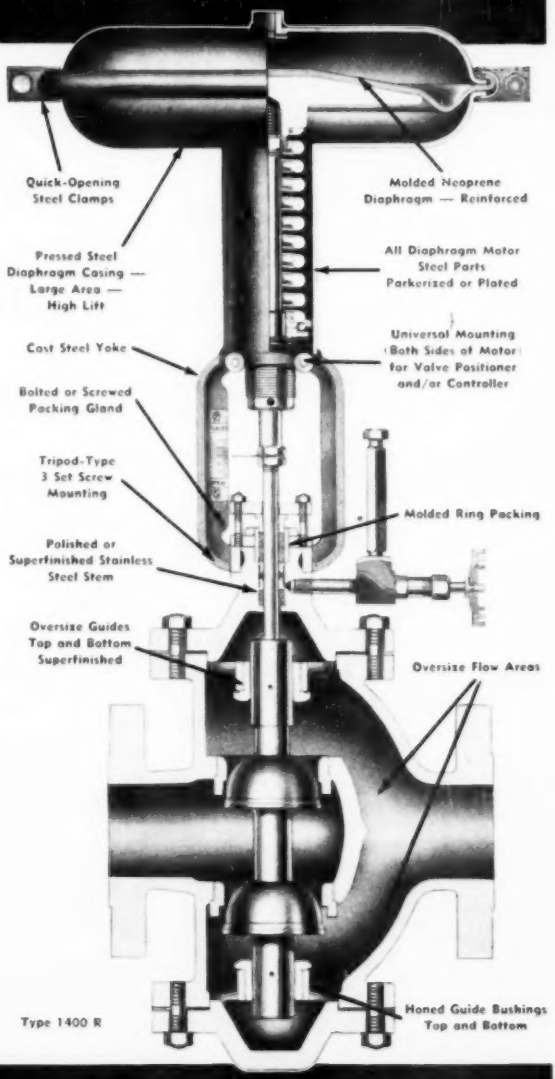
Five years ago, K & M Advanced-Type Control Valves were new to industry. Today, with outstanding performance records behind them, K & M valves have become first in the regard of many instrument engineers. Increasingly, K & M representatives are called upon to give counsel and assistance in the planning of new control installations and the improvement of old ones. During the past year K & M men have been consulted on most of the projects in which control valves have been a major consideration.

***There is a qualified K & M representative near you, eager to discuss your problems and able to help you with them.***



Type 1200 Type 1000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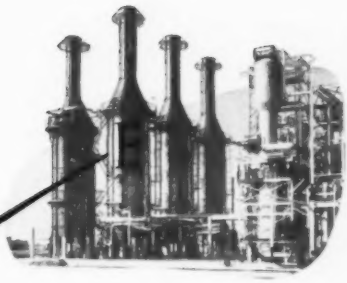

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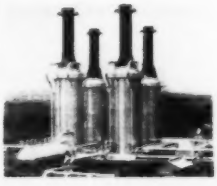
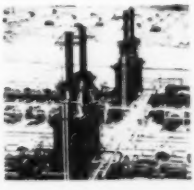
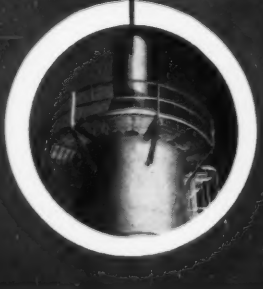




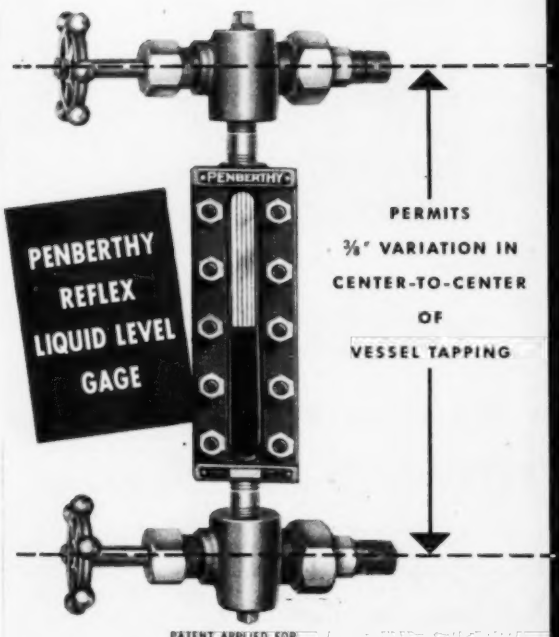


**PETRO-CHEM**

**ISO-FLOW FURNACES**



*(To obtain more data on advertised products see page 1428)*




PATENT APPLIED FOR

**Another PENBERTHY First**

# PENBERTHY "Floating Shank"

## *Saves Time and Money* in Gage Installation

A feature available only on Penberthy drop forged steel (and alloy) gage valves, the "floating shank" automatically compensates for as much as 3/8" variation in the center-to-center distance of the vessel tapping. This saves time and cuts the cost of gage installation . . . eliminates stresses often induced during mounting. Penberthy "floating shank" is available at slight additional cost. It will pay you well to specify "floating shank" on your next gage order.

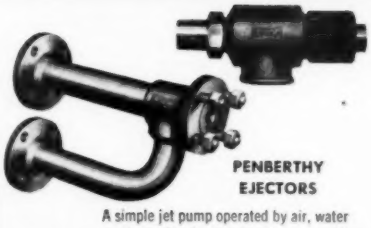
## OTHER PENBERTHY PRODUCTS

### PENBERTHY TRANSPARENT GAGE

Used to observe color and density of liquids under high pressures and/or temperatures. Exceptionally sturdy construction—liquid chamber machined from solid block of metal. Ask for Catalog 35

### PENBERTHY CYCLING JET PUMPS

Automatically operated by air, gas or steam pressure . . . Will pump without clogging any liquid that will flow through pipes. Ask for Bulletin 5030.

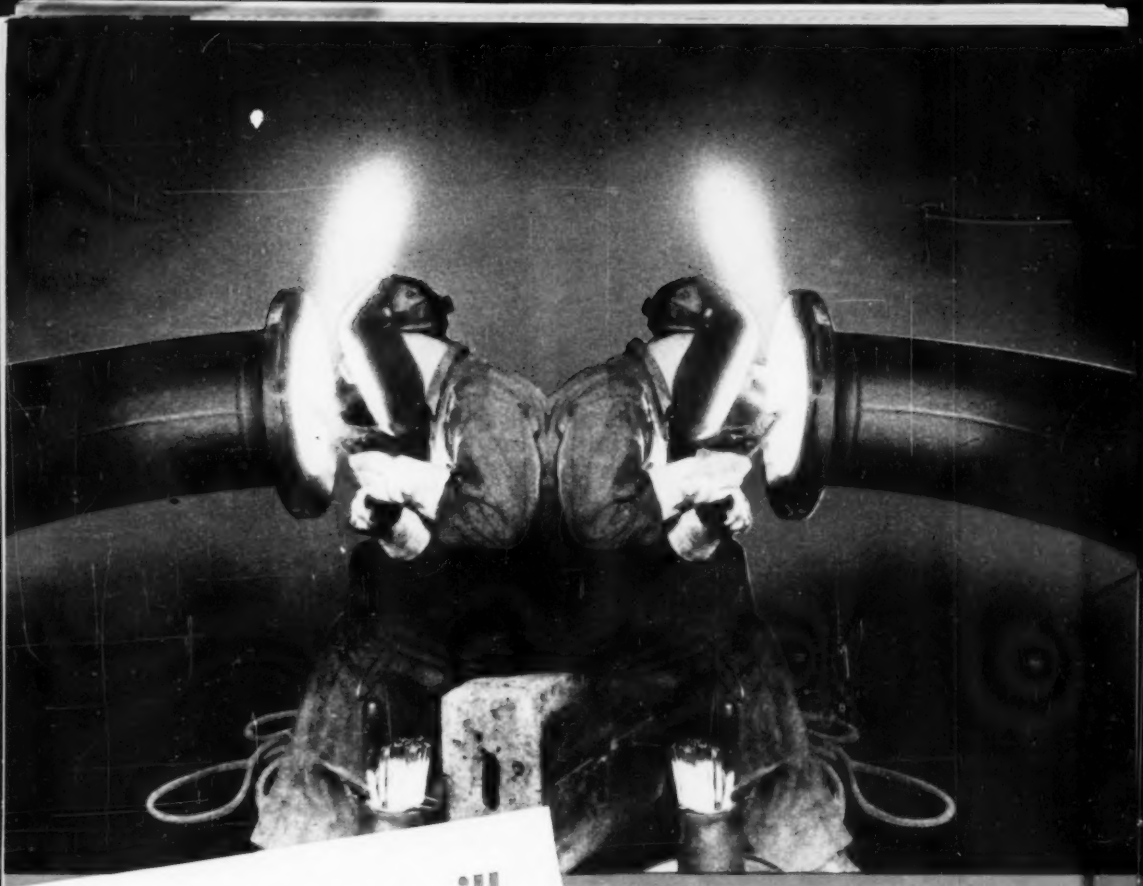


### PENBERTHY EJECTORS

A simple jet pump operated by air, water or steam. Needs no lubrication . . . will not get out of order. Made in wide variety of materials and special units developed to meet unusual conditions. Ask for Bulletin 512.

4671

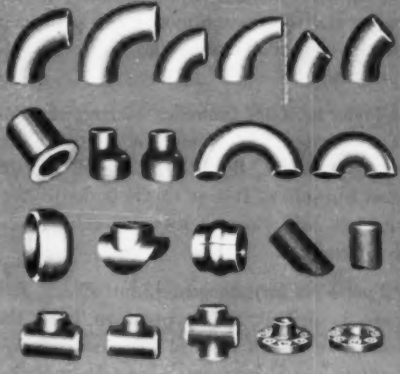
**PENBERTHY INJECTOR COMPANY**
DIVISION OF THE BUFFALO-ECLIPSE CORPORATION
DETROIT 2, MICHIGAN
*Established 1886* *Canadian Plant, Windsor, Ontario*



# Your welders will seem like *Siamese Twins*

When they use Midwest Welding Fittings, your welders will turn out so much more work that they'll seem like Siamese Twins. The reason? . . . The exceptional accuracy and uniformity of Midwest Welding Fittings enable your welders to spend more time welding and less time in preparation.

**MIDWEST WELDING FITTINGS IMPROVE PIPING DESIGNS AND REDUCE COSTS**

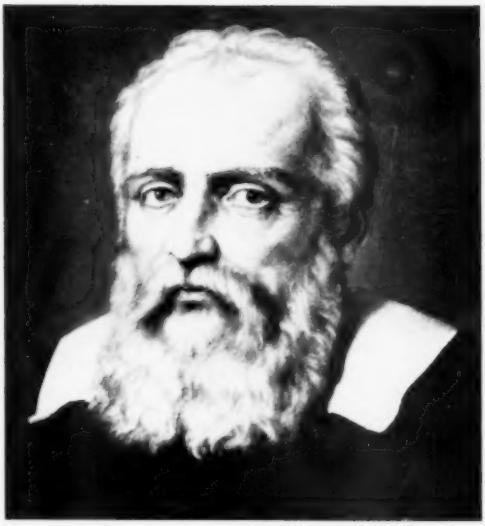


**MIDWEST**
**PIPING & SUPPLY CO., Inc.**

Main Office: 1450 South Second Street, St. Louis 4, Mo.
Plants: St. Louis, Passaic, Los Angeles and Boston
Sales Offices: New York 7—30 Church St. • Chicago 3—77 West Monroe St.
Los Angeles 33—820 Anderson St. • Houston 2—1213 Capitol Ave.
Tulsa 3—234 Wright Bldg. • Boston 27—426 First St.

**STOCKING DISTRIBUTORS IN PRINCIPAL CITIES**

4943



# How many do

**Whether you recognize the first** three faces or not, we think you'll know the fourth one. There are thousands of these Taylor FULSCOPE* Controllers in service today, in almost every process industry from chemicals to milk, from petroleum to plastics.

**A Taylor FULSCOPE Controller** is a rugged, dependable air-operated instrument for control of temperature, pressure, flow, liquid level, density, load and humidity. It was the first controller on the market with completely interchangeable unit construction.

**All parts are interchangeable,** and every FULSCOPE case is drilled and tapped to hold the most complete set of control responses. Simple controllers can be converted into the most complex, if necessary, right in the field; repairs can be made quickly by your own instrument man.

*Reg. Trade-Mark

**The six standard types of FULSCOPE Controllers** fit almost any processing need:

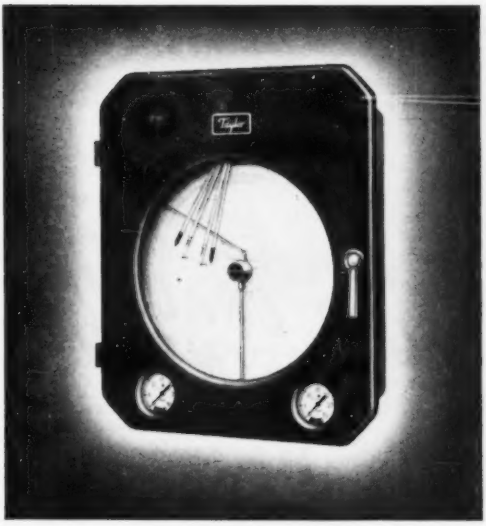
1. For simple on-off control on applications with small time lags and large capacities, regardless of load change, buy a *Fixed High Sensitivity* model.

2. For throttling control on similar applications, you need *Adjustable Limited Range Sensitivity.*

3. Throttling control where you have a wide range of time lags and capacities, infrequent or negligible load changes, calls for *Full Range Adjustable Sensitivity.*

4. Precision control under a wide range of time lags and capacities, with gradual, sustained load changes, calls for *Adjustable Sensitivity with Automatic Reset.*

5. Where there are momentary disturbances, but no sustained load changes, get *Adjustable Sensitivity with Pre-Act.*



# you recognize?

**6.** To meet almost any control problem, get the FULSCOPE Controller with all three control effects: *Adjustable Sensitivity, Pre-Act* and *Automatic Reset*. It gives precision control on applications with a wide range of time lags and capacities, and sudden, sustained load changes.

**Ask your Taylor Field Engineer** how FULSCOPE Controllers can help solve a big majority of your control problems, protect product quality and save money too. Write for Bulletin 98151.

**Where pneumatic transmission** is preferred, and particularly where graphic panels are wanted, ask about Taylor's revolutionary new three-part TRANSET* Control System too. Write for Bulletin 98097. Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.*

**Still wondering who the men are?** All are founding fathers of the instrument industry. First on the left above is Torricelli, who made the first barometer. Next is Galileo, maker of the first thermometer, and then comes Boyle, who discovered Boyle's Law. The face on the right, of course, is the famous Taylor FULSCOPE Controller. It is found in practically every process industry.

Taylor's Centennial
ACCURACY FIRST
SINCE 1851

**Taylor Instruments**
**MEAN**
**ACCURACY FIRST**
**IN HOME AND INDUSTRY**


*(To obtain more data on advertised products see page 1428)*

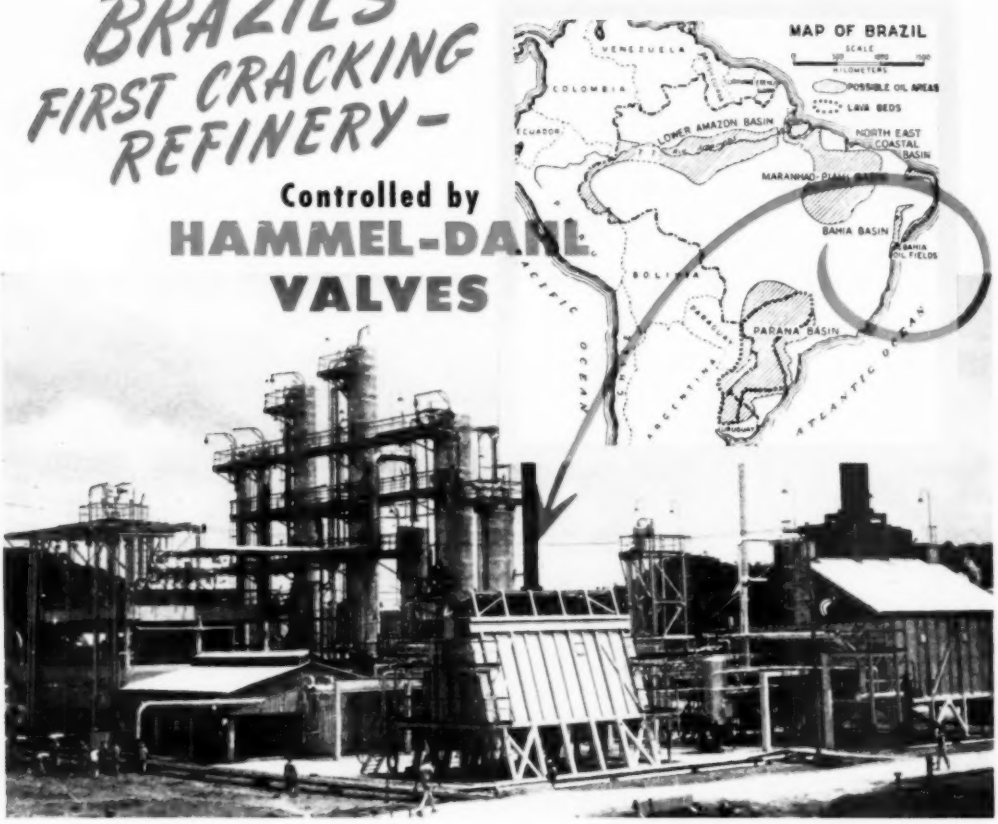
# AUTOMATIC CONTROL EQUIPMENT

ENGINEERED DESIGN BY **HAMMEL-DAHL**

## BRAZIL'S FIRST CRACKING REFINERY—

Controlled by

**HAMMEL-DAHL VALVES**



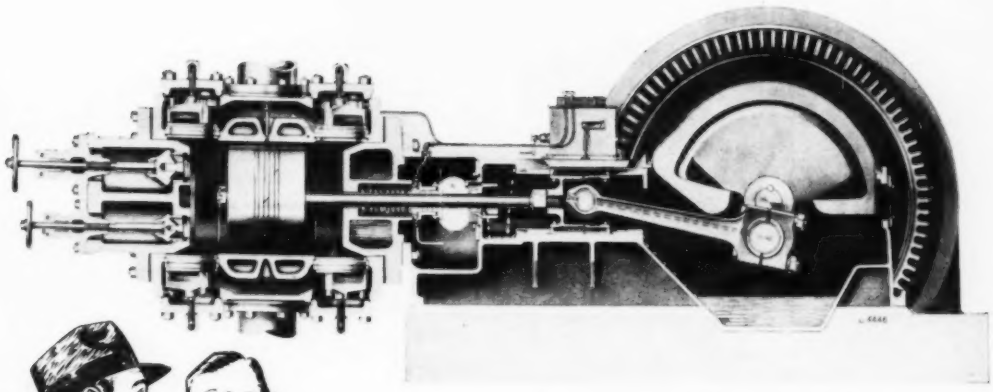

This new 2500 barrel per day Refinery — the first to produce cracked gasoline in Brazil — has recently been placed on stream at Bahia for Refinaria Nacional de Petroleo, S. A., by The M. W. Kellogg Company, refinery and chemical engineer-contractors of New York City.

*Consult your nearest H-D Sales Engineer for Precision Control of your Process*

**HAMMEL-DAHL COMPANY**

243 RICHMOND STREET, PROVIDENCE 3, R. I., U. S. A.

Albany Boston Buffalo Chicago Cincinnati Cleveland Denver Detroit Houston Kalamazoo
Kansas City Kingsport, Tenn. Los Angeles New Orleans New York Pittsburgh Salt Lake City
San Francisco Seattle Springfield, Mass. St. Louis Syracuse Toledo Tulsa Wilmington, Del.



*Cutaway of typical Worthington horizontal compressor which has many advantages for loads over 450 tons.*

# Why a Horizontal Compressor for the Heavier Refrigeration Loads?

Worthington, unlike other refrigeration compressor manufacturers, makes *all three* types of ammonia compressors—vertical, Y-type, horizontal—to cover the complete range of customer needs.

For the *heavier* loads, Worthington offers a complete range of *horizontal* compressors. Why? What are the advantages of horizontals for heavier loads?

***1. More work done.*** Only the horizontal is double-acting—that is, the piston is working on both strokes.

***2. Two stages of compression in one machine.*** For low-temperature work, the horizontal can have two stages of compression—no second or booster compressor needed.

***3. Easier maintenance.*** All parts of compressor accessible from working floor—no "high altitude" maintenance. Pressure is maintained only in the cylinder—so frame can be opened for maintenance without losing compression or the refrigerant.

***4. More flexibility.*** Horizontals can be installed duplex—that is, two cylinders on different frames operated by the same driver.

**Special reasons for using Worthington horizontal compressors include:**

1. **wide range of sizes up to 1000 tons**
2. **double-seal housing (optional)**
3. **variable capacity control (optional) of various types, including automatic**
4. **famous Worthington Feather* valves—simplest, most efficient ever made.**

Investigate *more worth with Worthington.* Consult Classified Telephone Directory for nearest Worthington distributor. Worthington Pump and Machinery Corporation, Air Conditioning and Refrigeration Division, Harrison, N. J., specialists in air conditioning and refrigeration for more than 50 years.

*Reg. U. S. Pat. Off.

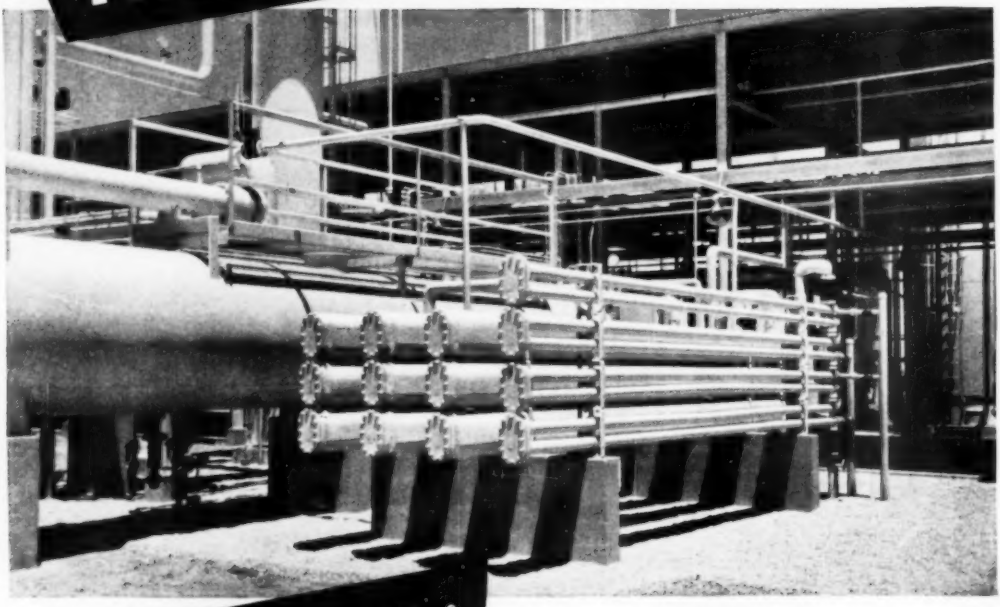
A-1.39

# WORTHINGTON

**AIR CONDITIONING AND REFRIGERATION**

**THE MOST COMPLETE LINE...ALWAYS THE CORRECT RECOMMENDATION**

# Assure Flexibility in your plant



with **BROWN FINTUBE** *sectional hairpin heat exchangers*

● You'll get almost unlimited flexibility to meet changes in duties, plant re-arrangements, etc., with Brown Fintube Sectional Heat Exchangers. By simply adding a few sections to your existing exchangers, or removing a few sections, or changing the series-parallel manifolding, change-overs can be made easily and quickly. You can be operating ***efficiently*** on almost any new or different duty, on short notice, with a minimum of expense for new equipment, and without obsoleting any of your former facilities.

For utmost efficiency and economy use Brown Fintube Sectional Heat Exchangers throughout your plant. ***Write for Bulletin No. 481.***

**THE BROWN FINTUBE CO.**

*Elyria, Ohio*

Sectional Hairpin Heat Exchangers
Tank Suction and Line Heaters
Fintube Heaters for Bulk Storage Tanks
Indirect Process Air Heaters
Fintube Heaters for Processing Tanks
Integrally Welded Fintubes for Any Heating, Cooling or Heat Transfer Service

NEW YORK • BOSTON • PHILADELPHIA • WILMINGTON • PITTSBURGH • BUFFALO • CLEVELAND • CINCINNATI • DETROIT • CHICAGO
ST. PAUL • ST. LOUIS • MEMPHIS • BIRMINGHAM • NEW ORLEANS • TULSA • HOUSTON • LOS ANGELES • SAN FRANCISCO

# Now You Can SEE Where You Can't LOOK

WITH THE

# DIAMOND "UTILISCOPE"

(WIRED TELEVISION)

On "Utiliscope" receiver, operator "sees" distant or dangerous operation in comfort and safety.

In industry, research, commerce, science, etc., many operations and conditions that need to be seen cannot be looked at because it is too difficult or too dangerous.

The "Utiliscope" (wired television) enables you to see where you can't look. Its camera eye can be placed in dangerous, remote or inaccessible spots and it will bring an exact image right to the operator. Moreover, several cameras can observe various parts of an operation or several related operations. Images of these directly in front of the operator enable him to accurately control the whole . . . concentrating responsibility and avoiding mistakes through erroneous information.

The "Utiliscope" saves manpower, improves product quality, increases production and prevents accidents.

The Diamond "Utiliscope" is surprisingly simple and low in cost. No special skill is needed for installation and operation. Its stability and reliability are exceptional. Ask for Bulletin 1025 which shows a wide variety of cost-cutting applications.

TYPICAL USES—Studying destructive tests of engines • Watching flow of molten steel • Checking remote gauge readings • Observing conditions inside furnaces • Viewing nuclear research • Coordinating materials flow on conveyors.

The "Utiliscope" (Reg. U.S. Pat. Office)

4593

**DIAMOND POWER SPECIALTY CORP.**

*FIRST IN INDUSTRIAL TELEVISION*

**LANCASTER, OHIO** • *OFFICES IN 39 PRINCIPAL CITIES*

*Diamond Specialty Limited — Windsor, Ontario*

**Since 1903, Diamond has Manufactured Quality Equipment For Industry**

**WRITE FOR BULLETIN 1025**

---

## This is An "Exploratory" Advertisement

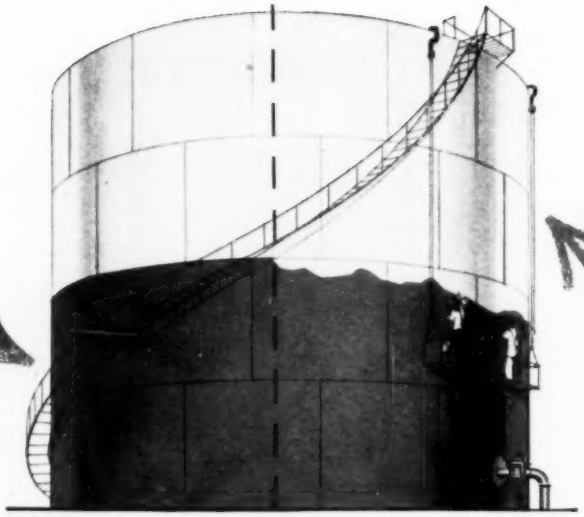
Frankly, we don't know what uses there are for the "Utiliscope" (Wired Television) in the oil industry . . . so in the adjacent ad we are simply telling you what it will do. Based on our experience in other fields, we suspect there are many places in the petroleum industry where the "Utiliscope" will improve product quality, save manpower, prevent accidents or help increase production.

If you want to look into the possibilities of the "Utiliscope", simply write us for a copy of Bulletin 1025B which explains the equipment and shows various applications. Please address your request to Department "B".

**Diamond Power Specialty Corporation**

**Department "B"**

**Lancaster, Ohio**



a good

# START...

## 4-way protection with SHERWIN-WILLIAMS KROMIK PRIMER

- **PENETRATES** into joints and rivet holes
- **PREVENTS** rust and corrosion
- **PROTECTS** against abrasion with tough, elastic film
- **WITHSTANDS** sun and weather, even without top coat

a better

# FINISH!

## Tough, long-lasting KEM® SYNTHETIC TANK PAINT

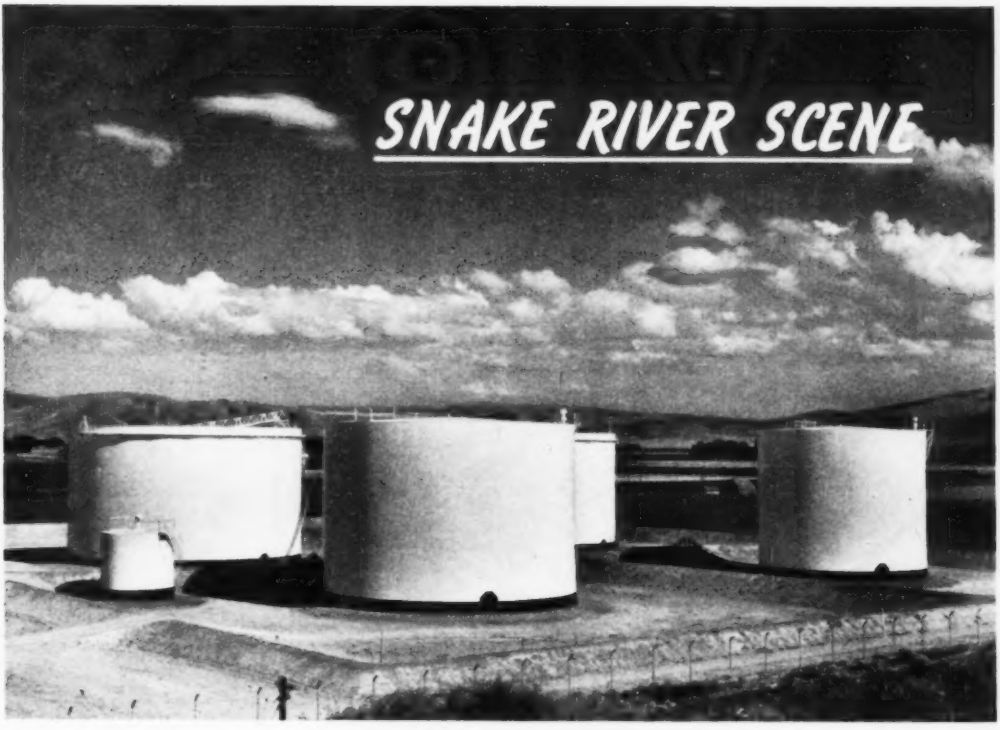
- **SELF-CLEANING**—stays brilliant white
- **HIGHLY REFLECTIVE**—reduces evaporation losses
- **FUME-RESISTING**—gives longer service

*Start* the job *right*—with the heavy-duty, *multiple-pigment* primer proved in more than 25 years of industry-wide service—Sherwin-Williams KROMIK Primer. KROMIK includes not only the best protective properties of red lead, but also those of three other protective pigments as well.

*Finish* the job *better*, because KROMIK provides the soundest possible foundation for long-lasting, brilliantly clean Sherwin-Williams Kem Tank White Finishes. Especially designed for petroleum service, their fume-resisting high reflectivity keeps temperatures lower within the tanks . . . reduces costly evaporation of high volatiles. Ask your Sherwin-Williams representative today for data on these or other of the complete line of Sherwin-Williams Petroleum Industry Finishes—or write The Sherwin-Williams Co., Transportation Division, Cleveland 1, Ohio.

**SHERWIN-WILLIAMS**

PETROLEUM FINISHES




# Horton* Tanks Symbolize Oil's New Frontier

The discovery and development of new oil pools in the Rocky Mountain states has transformed the entire area into a panorama of activity. Wildcat rigs—refinery towers—and storage tanks now dot a land where once only cattle and wheat dominated the scene.

On the picturesque Snake River near Burley, Idaho, the Horton storage tanks shown above serve the Utah Oil Refining Company. Three are cone roof installations while two other tanks are equipped with Horton Floating Roofs. Together they provide all the storage economies that modern design, fabrication and erection provide.

In storing gasoline or crude oil, Horton Floating Roofs *solve* three problems that often absorb profits. They greatly reduce or eliminate costly vapor losses—they protect the storage area from fire—and they reduce excessive corrosion inside the tanks.

Ask our nearest office for information or quotations on Horton Floating Roofs. They are built in three types—the Double Deck—the Pontoon—and the Pan to fit individual storage requirements. We also build Hortonspheres for efficient, economical high pressure storage of the more volatile hydrocarbons — Hortonspheroids and Hemispheroids to prevent excessive evaporation losses from hydrocarbons ranging in volatility from motor gasoline to natural gasoline—and Hortondome Roofs—to prevent evaporation losses from a single tank or several interconnected tanks during standing storage.

**Trademark Registered U. S. Patent Office*

## CHICAGO BRIDGE & IRON COMPANY

*Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA*

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| Birmingham 1 | 1527 North Fiftieth Street | Houston 2 | 2130 National Standard Building | San Francisco 4 | 1559–200 Bush Street |
| Boston 10 | 1029–201 Devonshire Street | Los Angeles 17 | 1526 General Petroleum Building | Seattle 1 | 1330 Henry Building |
| Chicago 4 | 2114 McCormick Building | New York 6 | 3310–165 Broadway Building | Tulsa 3 | 1620 Hunt Building |
| Cleveland 15 | 2215 Guildhall Building | Philadelphia 3 | 1630–1700 Walnut St. Building | Washington 6, D. C. | 1135 Cafritz Building |

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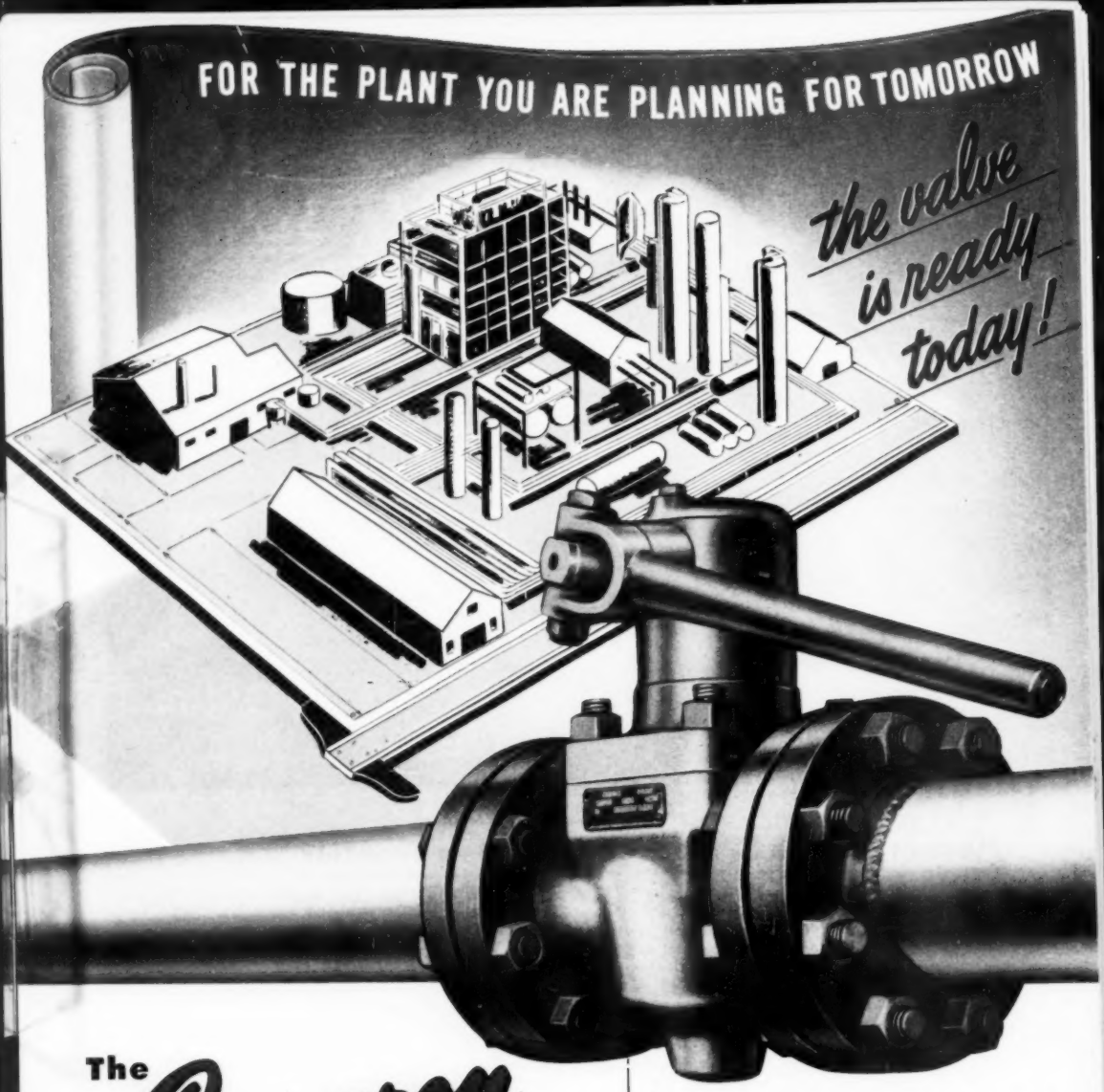
Constructions Metalliques de Provence, Arles-sur-Rhone, France
Chicago Bridge & Iron Company, Ltd., Apartado 1348 Caracas, Venezuela
Sociedade Chibridge de Construccoes Ltda., Av. Franklin Roosevelt, 194 S/704-C Rio de Janeiro, Brazil
Compagnia Tecnica Industrie Petroli, Rome, Italy
Whessoe Limited, Darlington, England
Motherwell Bridge & Engineering Company, Limited, Motherwell, Scotland
Comprimo N. V., Amsterdam-O, Netherlands

FOR THE PLANT YOU ARE PLANNING FOR TOMORROW

*the valve is ready today!*



The *Cameron*

NON-LUBRICATED

**LIFT-PLUG VALVE**

*-give it the "acid test" in your plant for first hand performance data!*

After six years of testing and service in the most difficult chemical services, and under elevated temperatures, high pressures and vacuum, the Cameron Non-Lubricated Lift-Plug Valve has proved superior to conventional designs.

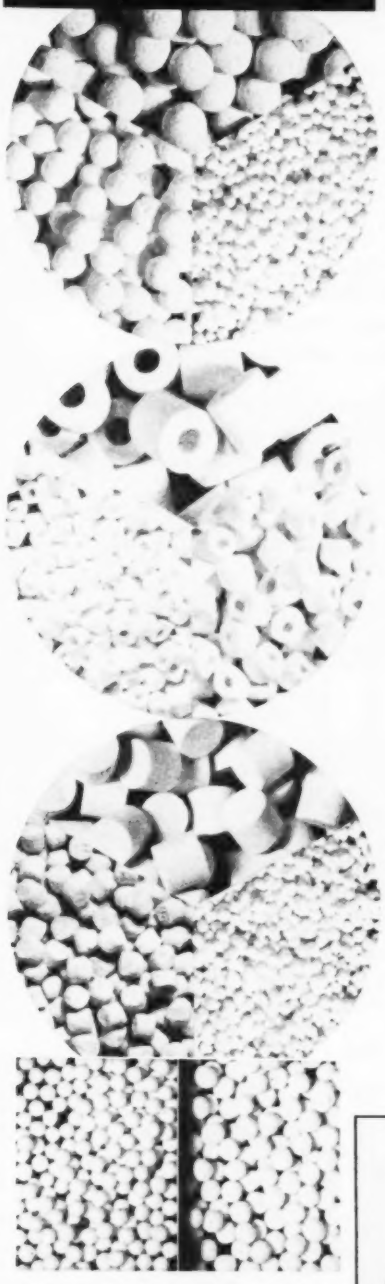
Featuring a renewable seat, which is separate from and not attached to the valve body, the Cameron Lift-Plug Valve offers a new approach to basic valve design, providing a tight seal and easy operation without the use of lubricants. The separate and renewable seat also makes for low maintenance and easy trimming for corrosive services.

*Cameron* IRON WORKS, INC.

P. O. BOX 1212, HOUSTON, TEXAS

Export: 74 Trinity Place, New York, N. Y. Represented in the sterling area by: British Oilfield Equipment Co., Ltd., Duke's Court, St. James' s, London S.W.1, Eng.

To meet varying needs, Norton catalyst supports are available in spheres, rings, and pellets.



Spheres can be obtained with either smooth or rough surfaces.

# *For Greater Yield or Lower Costs Investigate* Norton Catalyst Supports

Products of 40 years of pioneering in the development of special refractories, Norton catalyst supports come in a variety of materials, structures, shapes, and sizes that cover practically every known requirement for these vital aids to modern chemical processing.

In particular, Norton spherical supports provide a bed of exceptionally uniform composition for the passage of gas, thereby reducing channelling and pressure drop to a minimum. Spheres are made in diameters of ¼" to ¾" of the following Norton refractory materials: ALUNDUM*, CRYSTOLON*, MAGNORITE*, FUSED STABILIZED ZIRCONIA, and MULLITE. Each material has its own special properties as a catalyst support, and each has the chemical stability and purity that eliminates contamination of both catalyst and end products.

Also obtainable in these materials are Norton supports in ring or pellet form, in diameters of ⅛" to 2". Like the spheres, they have the high refractoriness and resistance to abrasion that insure long service life. Important advantages of all Norton catalyst supports are: controlled structure, highly suitable for coating or impregnation; porosity ranging up to 50%; and, in spheres, a choice of rough or smooth surfaces.

**Make a Thorough Test**

of Norton catalyst supports. Find out what they will do to improve your production through greater yield or lower costs. See your Norton representative or write direct for samples, describing your applications. Norton Company, 595 New Bond St., Worcester 6, Mass.

Canadian Rep. A. P. GREEN FIRE BRICK CO., Ltd. Toronto, Ont.

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

NORTON

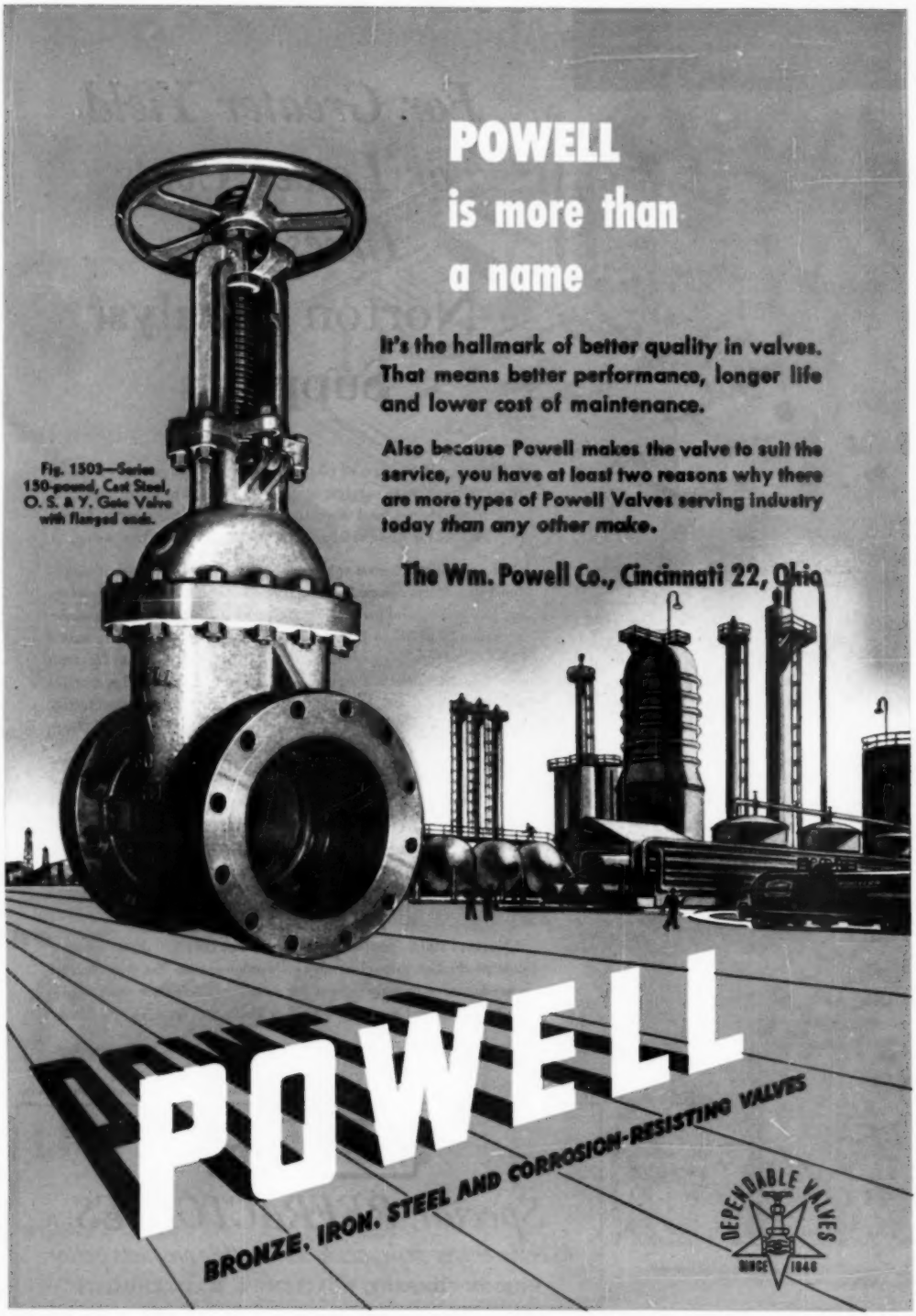
*Special REFRACTORIES*

*Making better products to make other products better*

NORTON COMPANY, WORCESTER 6, MASSACHUSETTS



*(To obtain more data on advertised products see page 1428)*


POWELL
is more than
a name
It's the hallmark of better quality in valves. That means better performance, longer life and lower cost of maintenance.
Also because Powell makes the valve to suit the service, you have at least two reasons why there are more types of Powell Valves serving industry today than any other make.
The Wm. Powell Co., Cincinnati 22, Ohio
Fig. 1503—Series 150-pound, Cast Steel, O. S. & Y. Gate Valve with flanged ends.
POWELL
BRONZE, IRON, STEEL AND CORROSION-RESISTING VALVES
DEPENDABLE VALVES
SINCE 1846

## SERVICE LEDGER
1901-1951

ANGLO-IRANIAN OIL CO. LTD.
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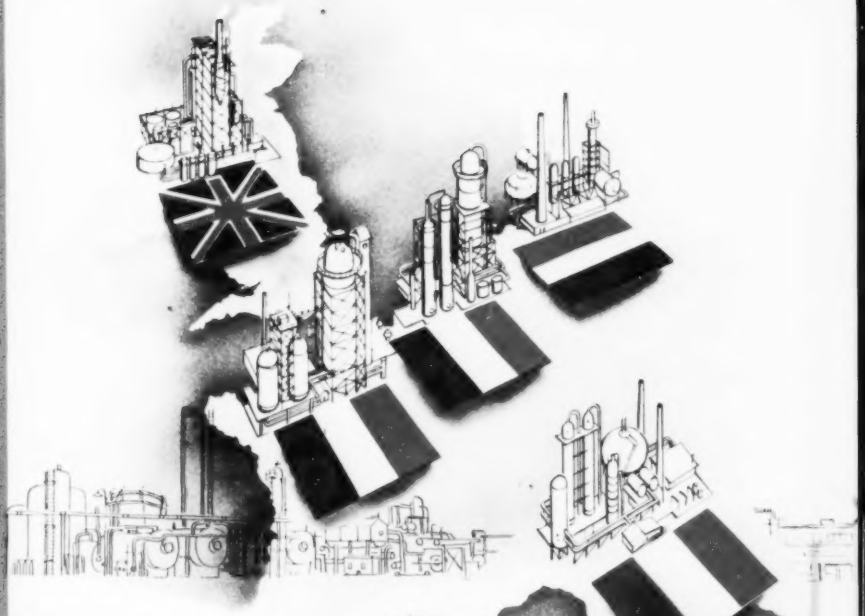
SHERWIN-WILLIAMS CO.
SINCLAIR REFINING CO.
SKELLY OIL CO.
SOCIETE DES RAFFINERIES DE PETROLE DE LA GIRONDE
SOCIETE GENERALE DES HUILES DE PETROLE
SOCIETE INDUSTRIELLE BELGE DES PETROLES
SOCONY-VACUUM FRANCAISE
SOCONY-VACUUM OIL CO.
E. R. SQUIBB & SONS
STANDARD OIL CO. (INDIANA)
STANDARD OIL CO. (OHIO)
STANDARD OIL CO. OF CALIFORNIA
SWIFT AND CO.
TEXAS CO.
UNION OIL CO. OF CALIFORNIA
UTAH OIL REFINING CO.
WASATCH OIL CO.
WOOD RIVER OIL & REFINING CO.



# *From Kerosine to Petro-Chemicals ...on the European Continent!*

Kellogg engineers have been working with international refiners since the days when kerosine accounted for a third of the liquid product sales . . . and pot stills were standard equipment. Subsequently, much of Europe's thermal cracking and other refining facilities were supplied by Kellogg.

Through the years, Kellogg has built complete refineries and refining units for the Continental affiliates of such international companies as Esso, Shell and Anglo-Iranian, as well as for the major national refiners of Belgium, France and Italy.

Currently, several major Kellogg designed plants are under construction . . . at Antwerp, Belgium; at Dunkirk and Gonfreville, France; at Ferrara, Italy. These projects encompass one complete refinery and many individual process units. Refining processes being utilized include atmospheric distillation, visbreaking, thermal cracking and reforming, propane deasphalting, Furfural treating, and Fluid catalytic cracking for the British Isles. Allied, though not an actual refining project, is Italy's first plant to produce olefins and their petro-chemical derivatives. This latter is Europe's second such plant, the first one having been designed by Kellogg for Imperial Chemical Industries in England.

## THE M. W. KELLOGG COMPANY
A SUBSIDIARY OF PULLMAN INCORPORATED

*for fifty years an integral part of processing history*

NEW YORK JERSEY CITY LOS ANGELES TULSA HOUSTON TORONTO LONDON PARIS

# Portrait at

*This year is Kellogg's fiftieth of service to industry. At this time naturally, as a group of men—known collectively to the modern business world as The M. W. Kellogg Company—we can think back nostalgically. We can remember the chimney stacks*

## "In the Final Analysis..."

*In previous issues of this magazine, "camera portraits" of M. W. Kellogg today have highlighted major aspects of Kellogg's operations, from basic research through the many steps to job-site construction.*

*This month, the camera takes a parting look at the construction lot and then focusses, through other company activities, on the over-all picture of Kellogg's service to industry.*

1. *KELLOGG'S CONSTRUCTION FORCE* is permanently staffed, right down to key craft foremen. This proves particularly advantageous in the specialized installation of high-pressure, high-temperature utility power piping. Accurate pre- and post heat as well as welding procedures must be followed to insure perfect fabrication of the alloys now being used for this type of service.

4. THE "PAY OFF" in Kellogg's business is revealed by two ostensibly unrelated activities—accounting and initial operation of equipment or plants. Both contribute to the final evaluation of a job: *How well did it work out cost wise? How well does it perform the job for which it was designed?* From this office Accounting Control is exercised over all Kellogg projects. Spotlighting true costs of even minor activities, this department illuminates the path to lower costs and keeps field supervisors continually cost conscious.

5. *"OPERATING INSTRUCTIONS"* are delivered to customers with completed Kellogg process units. The *practical* operating men who "build" these books start on the task with the inception of each project in the Design Engineering Department. In this way, they make certain that all features required by the customer for efficient operation are incorporated in the final design.

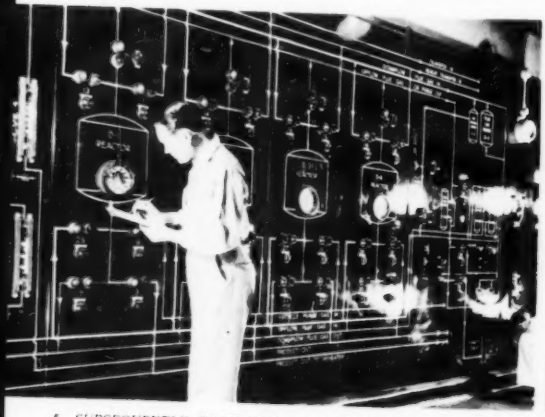
# fifty... no. 11

KELLOGG
1901 1951
50th Anniversary

*we built in 1901 . . . the first crude vessels for oil refiners in the 'teens . . . our first combination unit . . . the forty-odd Fluid cat crackers built in these years. But, after all, The M. W. Kellogg Company is only a factor as it is able to serve industry today. For that reason, we are presenting this series of monthly camera studies which document our belief that a truly integrated organization can better serve industry to achieve greater earning power. This is No. 11 in the series.*

**2.** *BOTH THE GAMMA AND X RAY* testing equipment, usually associated only with the highest quality shop fabrication, are taken *out into the field* by Kellogg. Originally, much of the equipment was not only specially designed, but in some cases built by Kellogg people. Pictured is one of the company's complete test laboratories on wheels.

**3.** *COMPLEMENTING THE CONSTRUCTION DEPARTMENT* is a division that concentrates on the erection, maintenance and repair of radial brick, common brick and concrete industrial chimneys. This activity has been a Kellogg specialty for nearly fifty years, and a complete staff of chimney engineers provides both new chimney design and an inspection service.



**6.** *SUBSEQUENTLY, THESE MEN* go into the field and personally check to see that each part of a new unit is completely operable in accord with design specifications. Then, they stand by in an advisory capacity to the customer's regular operating crews throughout the period of initial operation.

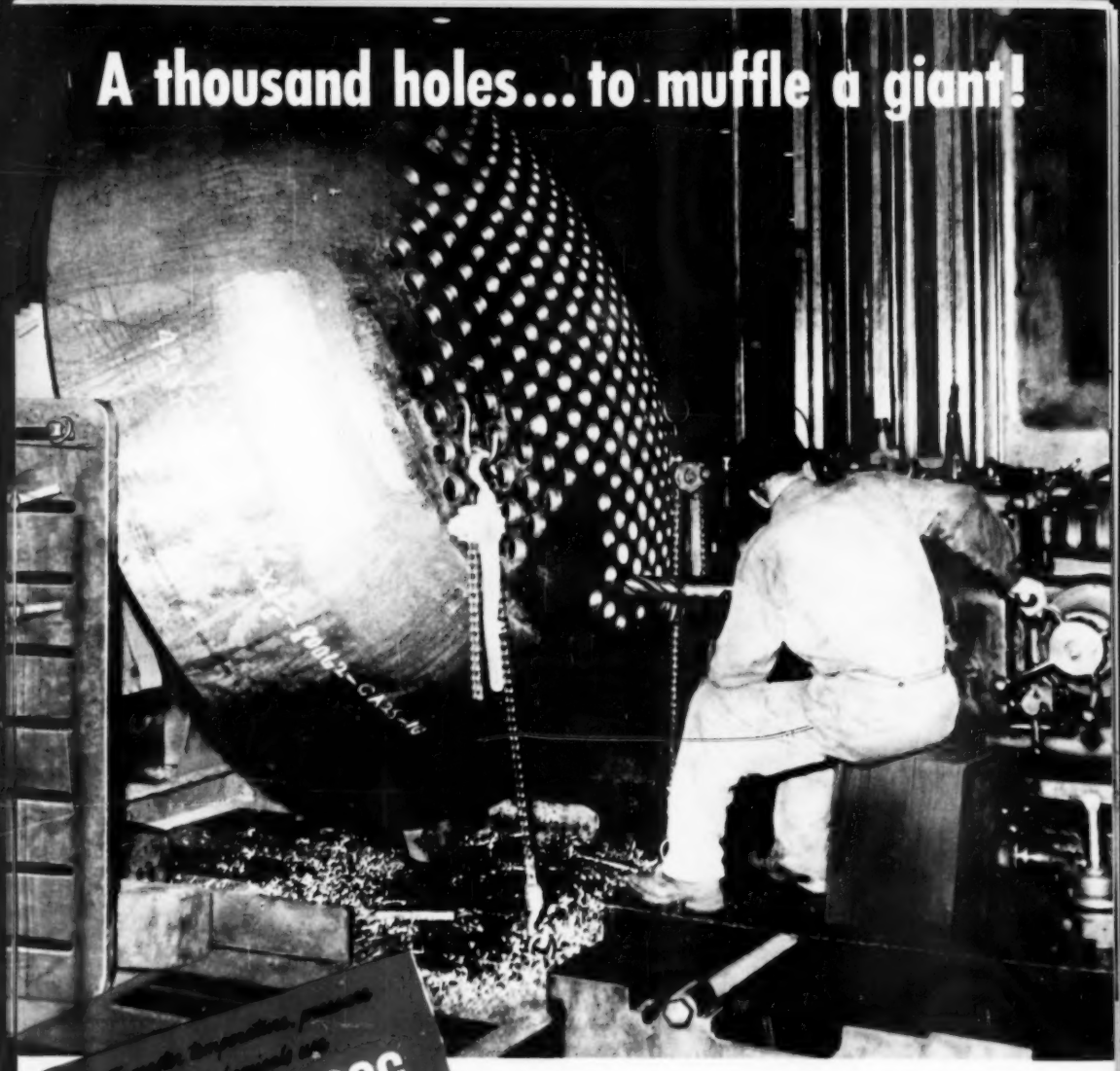
THE CUSTOMER
SINGLE RESPONSIBILITY
THE ENGINEER CONTRACTOR
ECONOMIC STUDY OF EXISTING OPERATIONS
APPROVAL OF PLANS AND ESTIMATES
ACCEPTANCE OF OPERATING PLANT
DETAILED MECHANICAL DESIGNS
SCHEDULING PURCHASING EXPEDITING INSPECTING INSURANCE
INSTALLATION AND CONSTRUCTION
LABOR RELATIONS
INITIAL OPERATIONS TRAINING OF PERMANENT CREWS
PLANT OPERATING TO MEET SPECIFIED ECONOMIC STANDARDS
PATENT CLEARANCE LICENSING
DETAILED PROCESS DESIGN
PROCESS CONCEPT TO MEET NEW ECONOMIC STANDARDS
PLAN TO CORRECT ECONOMIC DEFICIENCIES

**7.** *THUS IS KELLOGG COMPLETELY INTEGRATED* to serve its customers from initial plan to operating unit . . . integrated to provide every factor, that can contribute *Greater Earning Power* and *Greater Value* to every customer's project.

**P. S.**

*. . . this is the final camera study in the series presented during Kellogg's Fiftieth Anniversary year!*

# A thousand holes... to muffle a giant!



*Part of a huge muffler for a giant catalytic cracker, this perforated, dished, stack baffle is symbolic of Kellogg's especial forte in the field of heavy metal fabricating. It's a first of its kind . . . it requires unusual fabricating techniques . . . it's built to close tolerances!*

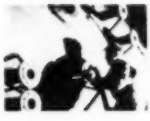
To make, transport, process and construct any

**M. W. KELLOGG**

process equipment

Pressure Vessels
Vacuum Vessels
Fractionating Columns
Drums and Shells
Heat Exchangers
Process Piping
Hi-pressure — Hi-temp Power Piping
Bends and Headers
Giant One-Piece Bends
Forged and Welded Fittings
Radial Brick Chimneys

**Continuing Study** of behavior of metals under stress at high temperatures has produced valuable design data.



**Shop Layout.** Craftsmen are fully experienced in vessel fabrication from nozzle positioning to "knockdown" fabrication for field assembly.

**Extensive Facilities** from forming of plate to final machining of precision surfaces permit complete fabrication under the same roof.

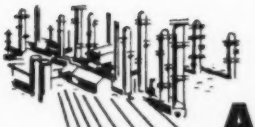
**Special Welding Techniques** and stress relieving methods assure equipment performance even under severest operating conditions.

**Rigid Quality Control**, devised by specialists, including chemical and micro analyses as well as mechanical and non-destructive testing.

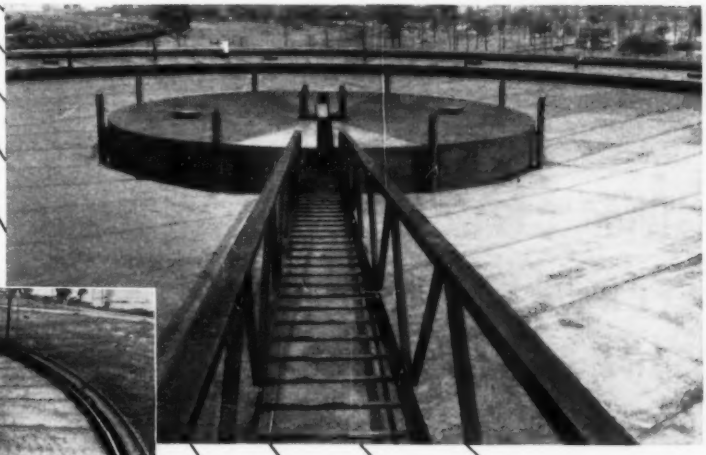
NEWS FOR OPERATORS IN WESTERN CANADA

The Canadian Kellogg Company Ltd. has established complete shop facilities for the fabrication of all types of piping at **EDMONTON**, Alberta. Inquire directly or through any Kellogg or Canadian Kellogg office.

**The M. W. Kellogg Company** *(A Subsidiary of Pullman Incorporated)* **New York, Jersey City, Los Angeles, Tulsa, Houston, Toronto, London, Paris**



# A GRAVER EXCLUSIVE



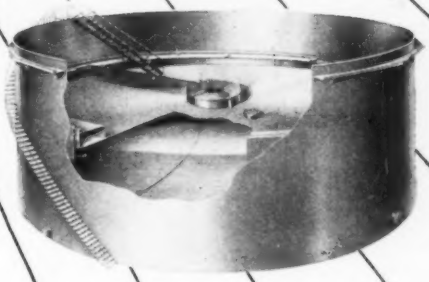
## GRAVER CENTER-WEIGHTED FLOATING ROOF TANK

### A PROVED DESIGN FOR 3-WAY ECONOMY

- No Corrosion — No Filling Losses
- Takes Less Steel To Build
- Lower Maintenance Cost

Built for the storage of crudes or finished petroleum products, the patented design of the Graver Center-Weighted Floating Roof combines the stability, the vapor-savings and the corrosion resistance of the Double Deck Floating Roof with the more economical aspects of the conventional pan-type roof.

Announced in November, 1950, after several years on the drawing board and a full year of exhaustive tests . . . this new design already has been widely accepted by the petroleum industry. New tanks with Graver's single deck floating roofs have been completed in six states with similar installations scheduled for nine more, covering all sections of the nation. Capacities of the tanks built and on order range from 20,000 to 150,000 bbls.; diameters from 60' to 150'.



GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

NEW YORK · CHICAGO · PHILADELPHIA · WASHINGTON
DETROIT · CINCINNATI · CATASAUQUA, PA.
HOUSTON · SAND SPRINGS, OKLA.

# "Model" Grease Plant FOR CANADIAN OIL COMPANIES, LTD.

This lucite, scale model was the "blueprint" used by Fluor engineers to plan and construct the new modern lubricating oil and grease manufacturing plant for Canadian Oil Companies, Ltd., in Montreal. Being able to work out detailed designs in miniature, played a big part in the successful selection and location of all equipment to facilitate the natural flow of work through the plant with a significant saving in man hours. It is an example of the thoroughness with which Fluor tackles a job.

Over 300 varieties of specially engineered greases and lubricants packed in a multitude of sizes, from 3 ounce cans to 55 gallon drums, are manufactured, blended, packaged and stored in this efficient plant. It had to be built in a U-shape to incorporate the original plant which still houses much of the blending machinery. It had to be accessible to all forms of transportation by land or water. It had to provide storage facilities for raw grease stocks before processing and for interior storage of finished products. It had to be equipped with the latest automatic devices for heating, blending, sterilizing, conveying, packaging, handling, etc. and it had to be completed in the shortest time possible.

Fluor's experience with building and remodeling plants which use bulk materials for a variety of products, has long been established, but at Canadian Oil much of the machinery is Fluor designed—especially that used for handling materials. The flexibility of this equipment is almost human in its ability to switch from one type of product to another, from one type of container to another and from one type of carrier to another whether it be truck, box car, tank car, freighter or tanker, without loss of time for change-over.

**FLUOR**

BE SURE WITH FLUOR

*Fluor's Engineering and Construction Division is one of the nation's foremost organizations in plant construction, from design to completion. For more information contact your nearest Fluor district office or representative.*

DESIGNERS AND CONSTRUCTORS of Refining, Natural Gas and Chemical Processing Plants.
MANUFACTURERS of Pulsation Dampeners, Mufflers, Gas Cleaners, Cooling Towers and Fin-Fan Units.

THE FLUOR CORPORATION, LTD., 2500 S. Atlantic Blvd., Los Angeles 22, California
New York, Chicago, Pittsburgh, Boston, Tulsa, Houston, San Francisco, Birmingham and Calgary.
REPRESENTED IN THE STERLING AREAS BY: Head Wrightson Processes Ltd., Teesdale House, Baltic Street, London, E.C.I., England

## Headquarters Insignia . . .

## . . . for Refiner's No. 2 Operating Material

Today, petroleum refiners use about 1,000 different chemicals in their routine operations, many of them in large volumes. Away up in *number two slot* on this formidable list is *sorptive minerals*—to the tune of some 200,000 tons per year. Adsorbents, as vital processing chemicals, are second only to sulfuric acid.

It is all the more significant, then, that Attapulgus Fullers Earths and Porocel Activated Bauxites have become recognized standards in the field of adsorbents. As of now, at least a billion barrels of petroleum cuts—from the lightest distillates to the heaviest lube and wax fractions—have been treated by Attapulgus or Porocel materials to gain remarkable finished value.

This all adds up to a lot of specialized experience—intimate acquaintance with the process techniques for removing odors, colors, tastes, moisture, acids, sulfur, fluorides and unsaturates from hydrocarbons, as well as for systems employing solid catalysts. And, of equal importance, laboratory and plant experience with the many treatments which precede the application of our two basic materials to specific adsorbent jobs.

Perhaps our broad knowledge can be of real help to you in selecting the right adsorbent and the right conditions. Our staff is at your service, without obligation.

**ATTAPULGUS CLAY COMPANY** *Fullers Earth* · **POROCEL CORPORATION** *Activated Bauxites*

**Dept. D, 210 West Washington Square, Philadelphia 5, Pa.**

# From DRAFTING TABLE to COMPLETED REFINERY TRECO GIVES YOU . . . .

## GREATEST ECONOMY and MAXIMUM EFFICIENCY

If your problem involves the remodeling of an old plant or the building of a complete new one . . . your first step should be to wire, write or telephone Treco. You'll get fast action without obligation.

*Maximum efficiency and greatest economy are not just words* from a dictionary. They are the culmination of years of experience — a closely-integrated organization capable of designing, engineering and constructing a refinery to best fit your present needs and projected future requirements. Even under today's problems of decreasing labor supply and the increasing difficulty of securing materials and equipment, Treco has been able to complete all jobs within the contractural requirements.

TRECO

REFINERY ENGINEERING Company

PHONE 5-5561 • TULSA, OKLAHOMA

# piping maintenance *costs more* now!

**You do less of it by using Dependable Quality**

## CRANE VALVES

*...That's why more Crane Valves are used than any other make*

*No. 3602 Small Steel Gate Valve*

**easy to use...easy to keep on the job**

You'll have much less valve maintenance wherever you install Crane 600-Pound Small Steel Gates. Use with recommended trim on oil or oil vapor, steam, water, air, or gas.

Compact yet rugged—light yet strong—these are truly small steel valves with big valve features. They sacrifice nothing that insures dependability and tight seating, easy operation, and convenience in keeping them in top-notch working condition.

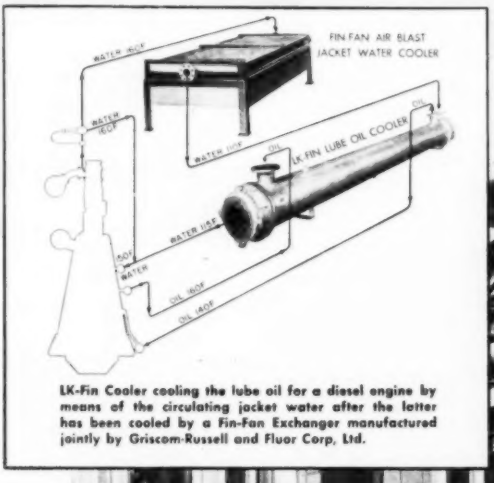
Supplied in sizes 2 inches and smaller, No. 3602 valves are engineered to the standards that make Crane Quality your best choice in valves of every type.

# CRANE CO.

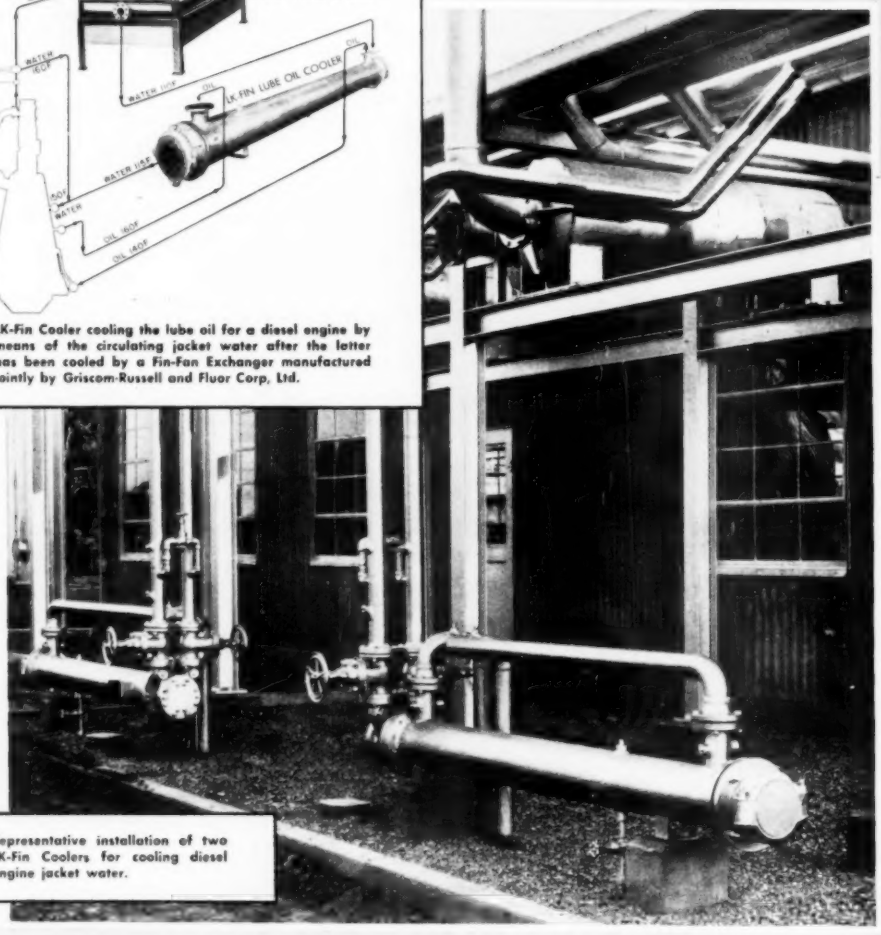
*General Offices:*
836 S. Michigan Ave., Chicago 5, Ill.
*Branches and Wholesalers Serving All Industrial Areas*

**VALVES • FITTINGS • PIPE • PLUMBING • HEATING**

# Why LK-FIN means a more




**LK-Fin Cooler cooling the lube oil for a diesel engine by means of the circulating jacket water after the latter has been cooled by a Fin-Fan Exchanger manufactured jointly by Griscom-Russell and Fluor Corp, Ltd.**



**Representative installation of two LK-Fin Coolers for cooling diesel engine jacket water.**

**GRISCOM-RUSSELL: PIONEERS IN HEAT TRANSFER APPARATUS**

# effective, compact, economical
# LUBE OIL OR JACKET WATER COOLER

It's because of the *fins* on the cooling elements. These fins greatly increase the external heat transfer surface . . . enable a considerably shorter tube to perform the same cooling effect that requires a much longer bare tube.

The results . . . a more compact cooler because of the more effective heat transfer surface . . . a more economical unit because of the shorter tubes and shell.

What diameter . . . thickness . . . pitch . . . should the fins be to accomplish these results? That's where G-R's unmatched know-how comes in . . . a knowledge gained from 20 years of experience in building *finned-type* heat exchangers and the results obtained from many tens of thousands of installed finned-tube units.

And the exclusive use of LK-Fin tubes is only one of the many distinctive features of these coolers. Write for bulletin describing them in detail, with rating tables and selection data.

THE GRISCOM-RUSSELL CO., MASSILLON, OHIO

GRISCOM-RUSSELL

GR 262

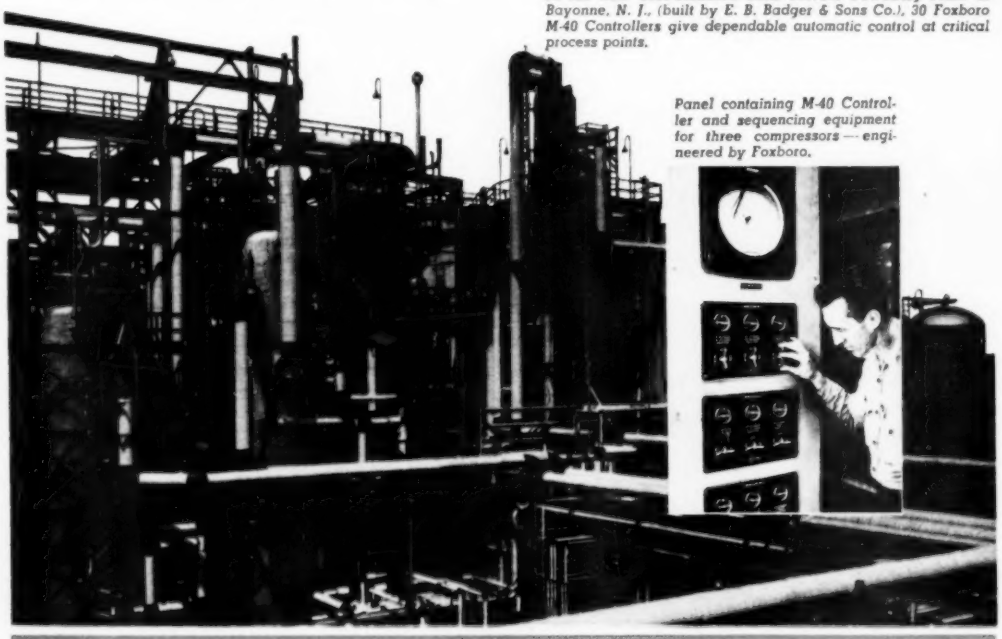
GRISCOM-RUSSELL: PIONEERS IN HEAT TRANSFER APPARATUS

# again... Esso Pioneers with Advanced Foxboro Controls!

In the new MEK Solvent Dewaxing Unit completed May 15, 1950, Esso-Standard Oil Company at Bayonne, N. J., cut costs and assured greater controllability of the entire process by means of the Foxboro Model 40 Controllers at many critical points. In addition, an economical feedback intercooling system, and a notably improved sequence control for the refrigeration compressors, were both developed around the Model 40 Controller.

The new Esso MEK installation typifies the many improved control systems now made possible by the inherent stability of Foxboro M-40 control action. M-40 Controllers give you the most advanced developments in the field of pneumatic instrument design. Available for temperature, pressure, flow, level and other applications. Write for full details. **The Foxboro Company, 24612 Neponset Ave., Foxboro, Mass., U. S. A.**

*In the new Esso Standard MEK Solvent Dewaxing Plant at Bayonne, N. J., (built by E. B. Badger & Sons Co.), 30 Foxboro M-40 Controllers give dependable automatic control at critical process points.*



*Panel containing M-40 Controller and sequencing equipment for three compressors — engineered by Foxboro.*

**FOXBORO** REG. U. S. PAT. OFF. **M-40 CONTROLLERS**

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

# RESISTS HOT ACETIC ACID and CHLORIDE VAPORS

**AT 158 TO 284 DEG. F.**

HASTELLOY alloy expansion joint

This HASTELLOY alloy C expansion joint is constantly exposed to acetic acid vapors saturated with acetyl chloride and containing small amounts of chloracetic acid. Alloy C is practically unaffected by these corrosive vapors at temperatures of 158 to 284 deg. F. Used at the top of a 24-foot distillation still, the joint is also elastic enough to compensate for the almost half-inch growth of the heated tower.

HASTELLOY alloy C and the other two grades of this nickel-base alloy—alloys B and D—are excellent construction materials for all types of processing equipment that must resist corrosive attack. In addition to their unusual corrosion resistance, alloys B and C have high mechanical strength and are available in both cast and wrought forms. Alloy D is available in cast form only. All three alloys are readily fabricated by most common methods. Fill out the handy coupon below for the whole story on these alloys.

"Haynes" and "Hastelloy" are trade-marks of Union Carbide and Carbon Corporation.

HAYNES Trade-Mark *Alloys*

**Haynes Stellite Company**
**A Division of**
**Union Carbide and Carbon Corporation**
UCC

USE THIS HANDY COUPON

Haynes Stellite Company, 725 So. Lindsay Street, Kokomo, Indiana

Please send me the new edition of your booklet, "HASTELLOY High-Strength, Nickel-Base, Corrosion-Resistant Alloys."

NAME_____

COMPANY_____

ADDRESS_____



*(To obtain more data on advertised products see page 1428)*

**ONE YEAR AGO** there was
1 UOP Platforming Unit in operation and
7 others were in various stages of design
or construction.

UOP

# New Johnson Platformer Now On Stream More Than 100 Days

By William J. Leenhouts
Refinery Manager
Johnson Oil Refining Company

The fifth Universal Oil Products Company Platforming unit was placed on stream at our Cleveland, Oklahoma, refinery on June 22. At 4:30 that afternoon, the first Platformate entered the product separation vessel making possible an economic leaded 95 octane product for the first time in the history of the refinery.

Wm. J. Leenhouts

The new unit is unique in that it was designed in such a way that a new fractionating tower and cooling system already on the premises could be used as the feed section of the Platformer. A control unit already located in the area also was utilized.

From the standpoint of the over-all refinery picture, the addition of the Platforming unit has not necessitated any major increases in our refinery personnel, with the exception of operators to take care of the Platforming unit itself.

The majority of pumps on the unit are motor-driven and the compressors are powered with gas engine drives — thus no expansion in the steam producing facilities was needed. Additional water cooling equipment has been installed to provide an increased water requirement.

The Platforming unit is designed to charge the total straight run which is separated from the crude at the crude unit. This fraction is charged to the unit from storage and processed first in a prefractionating column, which in this case, is the fractionating tower previously existing at the refinery.

The fractionating column is now used to prepare a Platformer reactor charge, taking the light fraction overhead, consisting essentially of pentanes and lighter and removing a bottoms cut to leave a reactor charge of controlled end point. The reactor charge which is taken as a sidecut from this column is pumped by means of a reciprocating pump and this stream is joined with the recycle hydrogen gas before going into the feed products exchanger. The total preheated feed is then passed through the convection section and through the No. 1 radiant coil of the Platformer heater.

Total feed is then processed through the No. 1 reactor where the temperature of the reactants decreases, depending on the nature of the feed reaction. The effluent from the No. 1 reactor is then reheated in the No. 2 coil in the heater and then passed to the No. 2 reactor where further reaction takes place.

The effluent from the No. 2 reactor is passed through the No. 3 radiant coil in the same heater and the feed is then processed in the No. 3 reactor, where the temperature drop is less than in the preceding reactors. The total effluent from

the No. 3 reactor is used as a source of heat for reboiling both the Platformer feed prefractionator and the total Platformate product.

Following the cooling of the total reactor effluent, the gas is separated from the liquid in a product separator with the bulk of the gas going to the recycle gas compressors for return to the reactor section. A portion of the net gas produced in the reactor is vented from this receiver and sent to the fuel gas system. This gas contains in the neighborhood of 85 per cent hydrogen.

Liquid from the product separator is charged to the stabilizer where in combination with the net light product from the prefractionator overhead, the total stream is stabilized to the desired product vapor pressure.

The following represents a summary of the operating conditions on the unit since the original startup. One period represents the normal operation and the second period represents the results which were obtained during the performance test run which was conducted on the unit shortly after the initial startup.

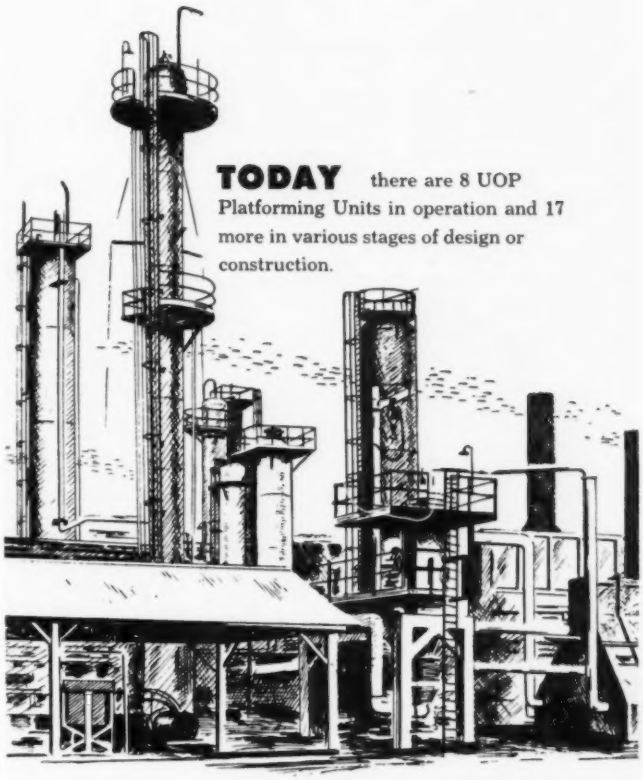
Platforming Unit Operating Results

| Period | 1 | 2 |
|---|---|---|
| Reactor charge BPD | 1980 | 1840 |
| Platformate yield vol. % of charge | 93 | 90.6 |
| Inspection | | |
| Platformate | | |
| Octane Numbers F-1 | | |
| clear | 80.6 | 84.1 |
| + 3 cc TEL | 93.4 | 95.5 |
| °API | 54.7 | 54.0 |
| Reid vapor pressure | 7.2 | 7.7 |
| Initial boiling point | 99 | 95 |
| 10% | 157 | 157 |
| 50% | 255 | 258 |
| 90% | 330 | 340 |
| End point | 397 | 402 |
| Reactor Charge | | |
| Octane Numbers F-1 | | |
| clear | 45.6 | 45 |
| + 3 cc TEL | 66.5 | 65 |
| °API | 56 | 55 |
| Reid vapor pressure | 1.5 | |
| Initial boiling point | 174 | 182 |
| 10% | 218 | 231 |
| 50% | 279 | 283 |
| 90% | 335 | 342 |
| End point | 370 | 380 |

The control of the process is easily accomplished since the feed rate has been set and recycle gas compressors have been set to deliver a constant volume of recycle gas, it is only necessary to determine what octane product is desired and to set the operating conditions desired in the three reactors to obtain this product.

Instrumentation in this unit is straight forward and required very little adjustment on the part of the operator. As a further aid, a special instrument has been devised which continually records the purity of the hydrogen produced from the process.

We at Johnson feel that the installation of the UOP Platforming unit represents another milestone in the progress of our company and are looking forward to an era of even greater efficiency and production of quality petroleum products.

**TODAY** there are 8 UOP Platforming Units in operation and 17 more in various stages of design or construction.

**WHAT BETTER PROOF**

of acceptance by the refining industry! Although it has been less than two years since the process was first announced . . . the 25 Platforming Units now in operation, or under design and construction, represent a total daily capacity of approximately 100,000 barrels.

**UNIVERSAL OIL PRODUCTS COMPANY**

UOP

General Offices: 310 S. MICHIGAN AVE., CHICAGO 4, ILL., U.S.A.

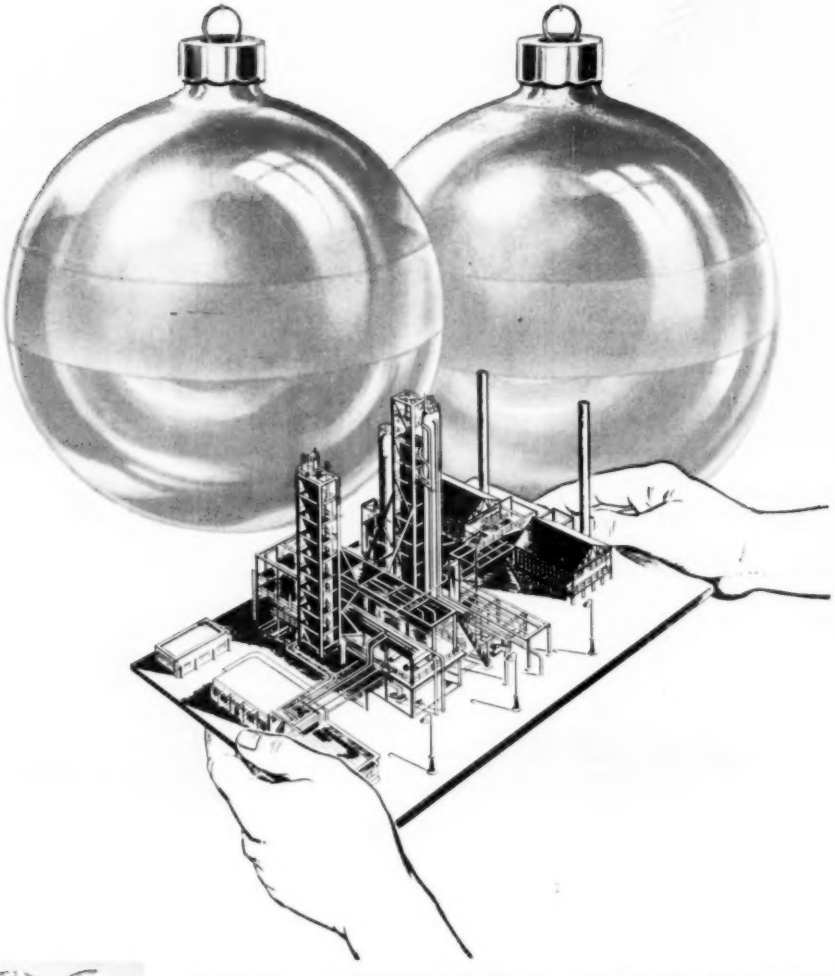
Laboratories: RIVERSIDE, ILLINOIS

*Universal Service Protects Your Refinery*




*(To obtain more data on advertised products see page 1428)*

*May your Christmas be happy*
*and the New Year prosperous*



LUMMUS

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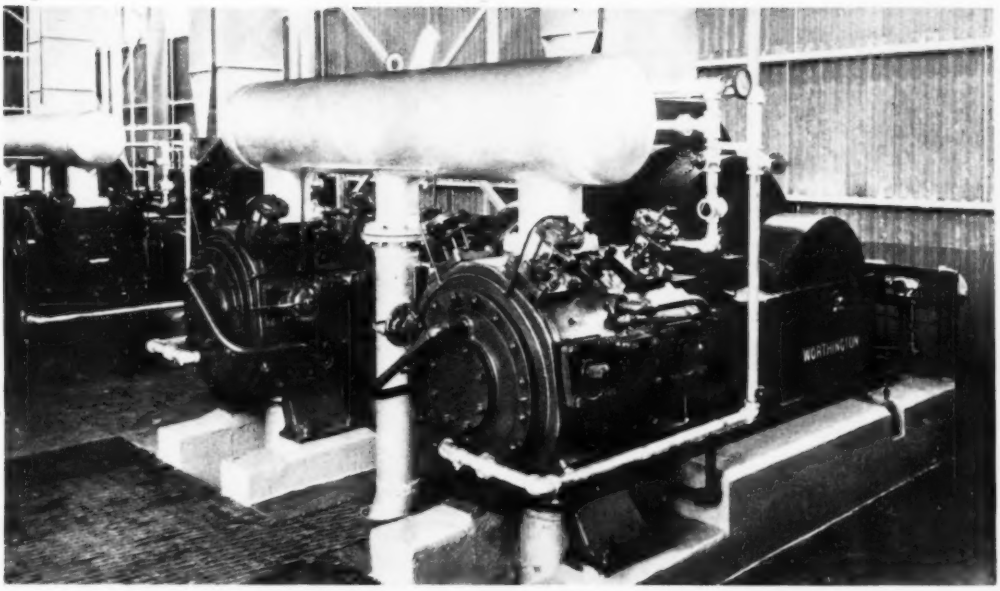
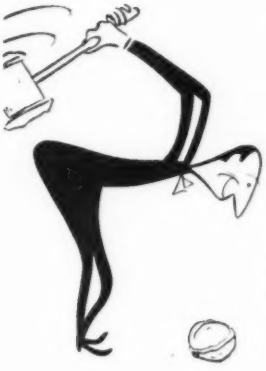


# A New Cracking System at Socony-Vacuum ...BUT THE SAME COMPRESSORS



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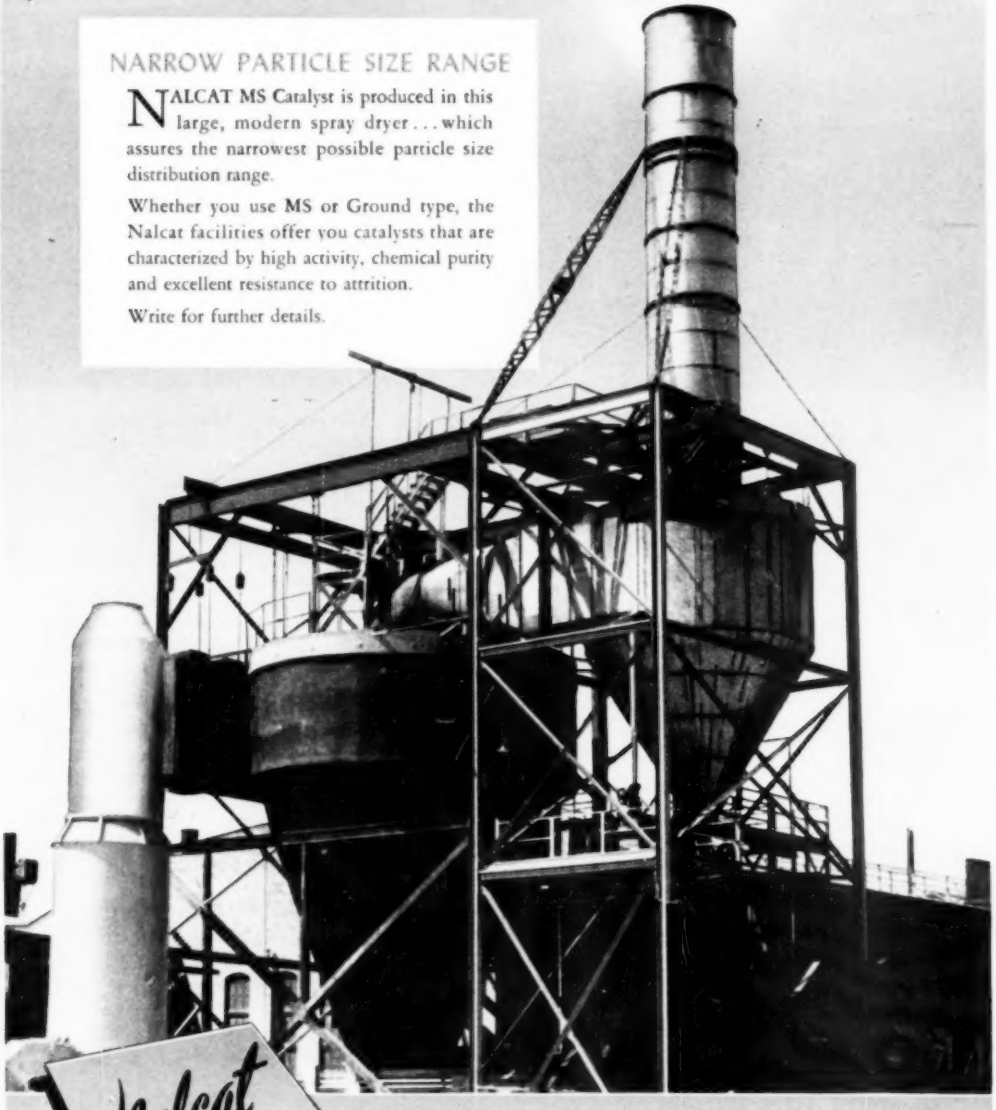

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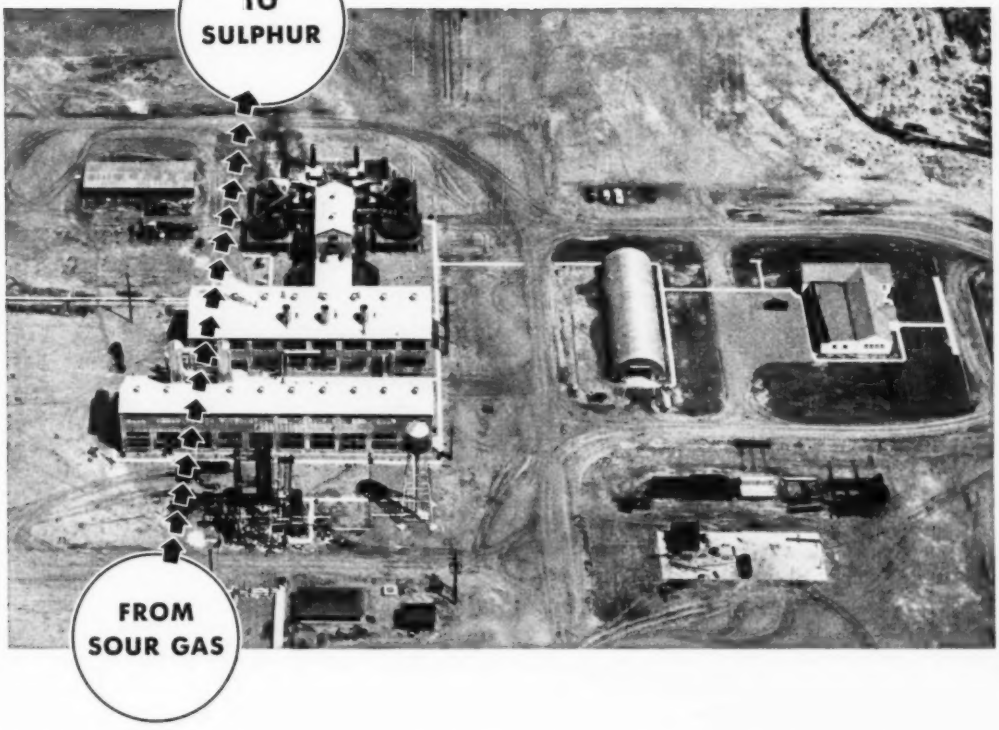


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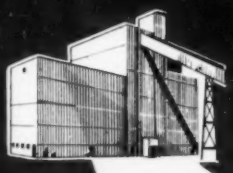

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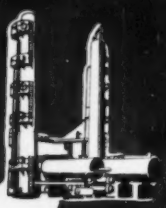

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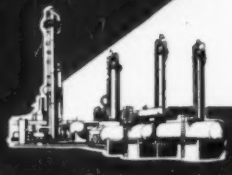
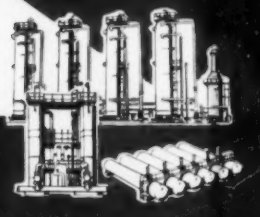
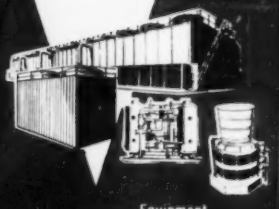


Petroleum



Natural Gas



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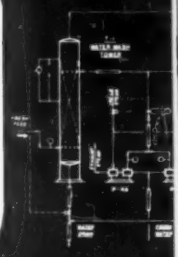

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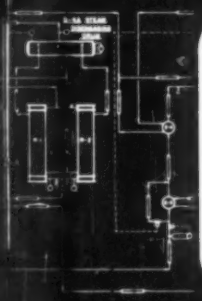

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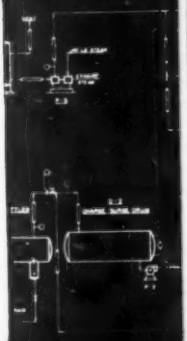

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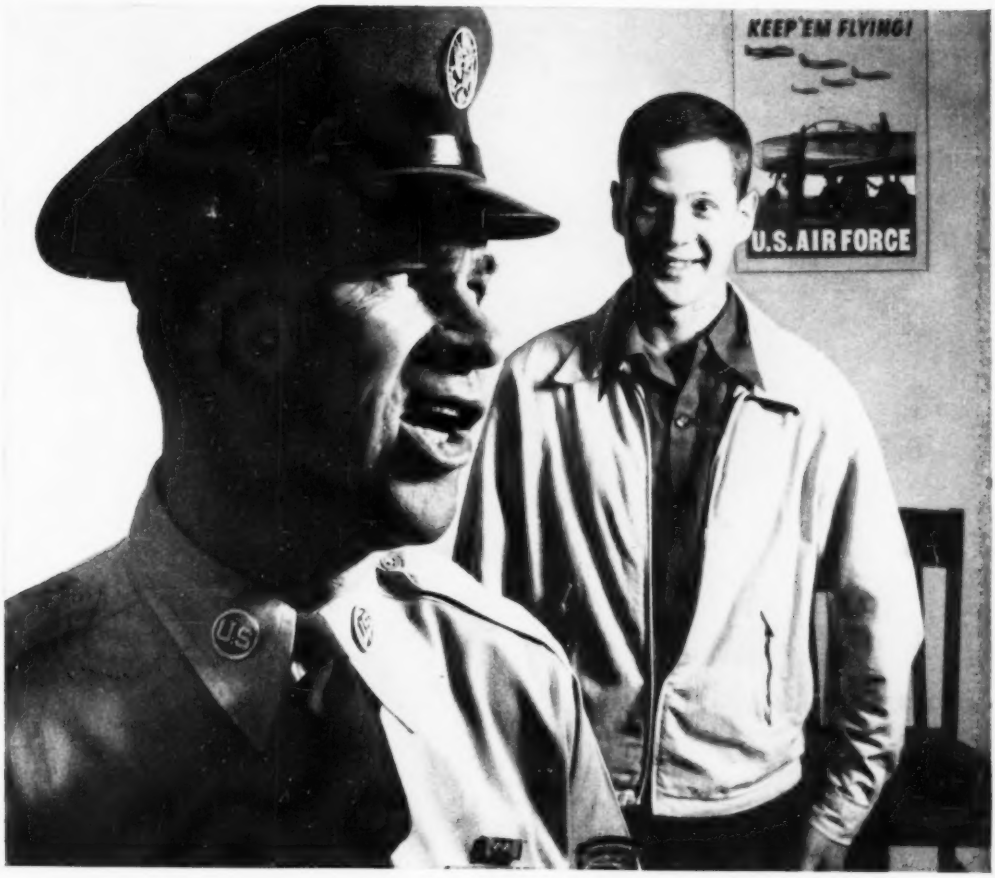


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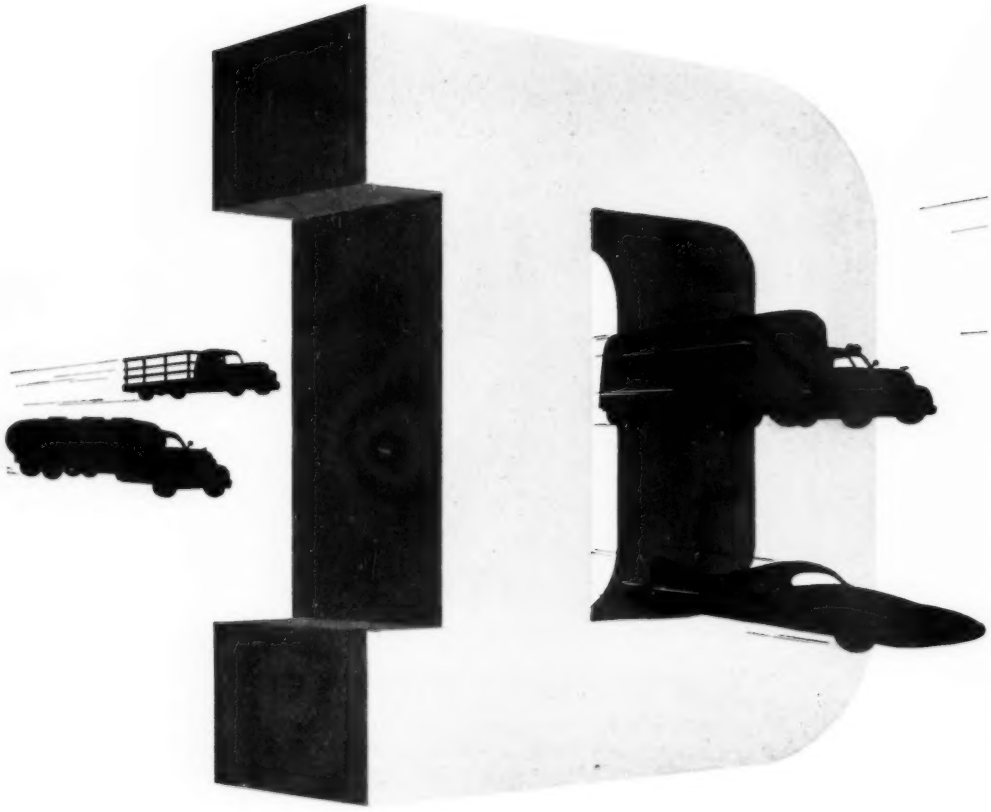

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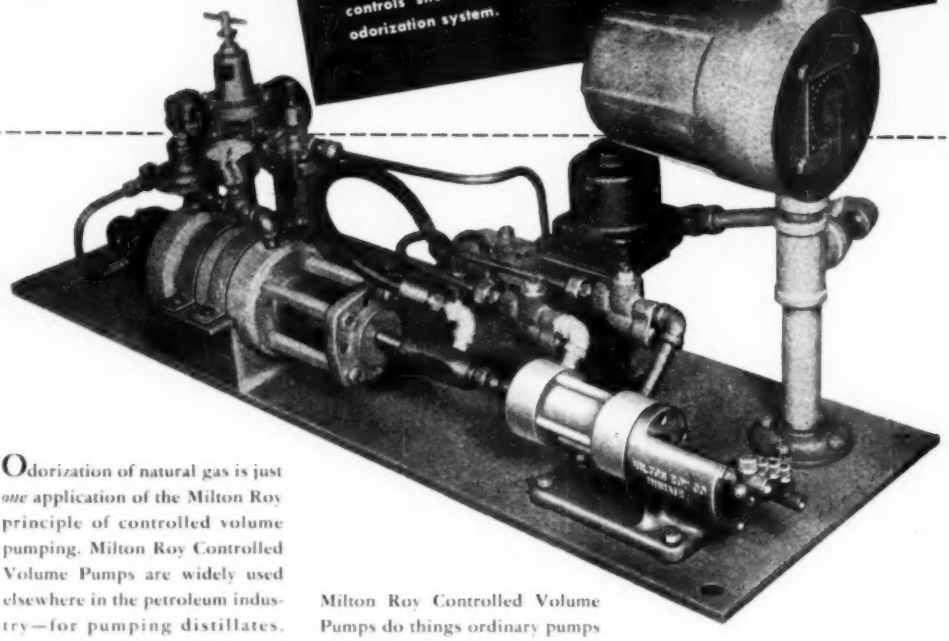

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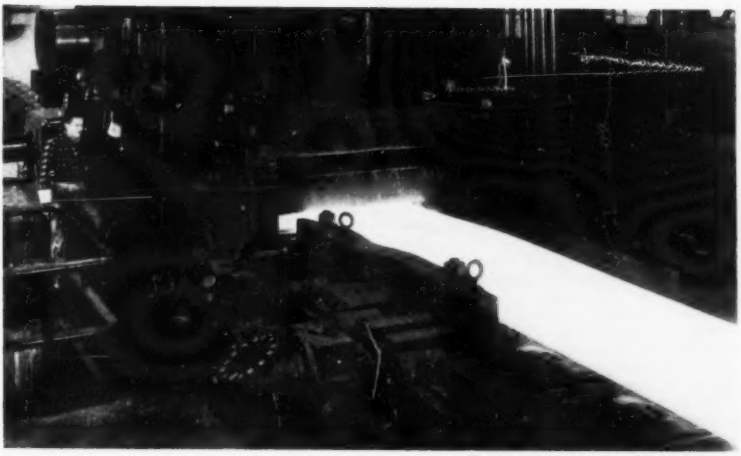

*Photo courtesy American Steel & Wire Co*

# Beating the Alloy Shortage

## Methods by which refiners can conserve use of critical steels are outlined at API symposium

*By V. B. GUTHRIE, Editor*

FIVE grades of chromium-molybdenum steels have been proposed as standard for refiners to use as a conservation measure during the present emergency, it was disclosed at the Interdivisional Symposium on the "Outlook for Steel" held Nov. 6 during the API annual meeting in Chicago.

The five tentative standard grades were prepared by the API Interim Advisory Committee on Alloy Steels, organized this past summer to advise the PAD on problems in connection with the critical alloys, and to suggest means for their conservation. The five grades suggested are:

(1)—carbon-0.5% molybdenum
(2)—1.25% chromium-0.5% molybdenum
(3)—5% chromium-0.5% molybdenum
(4)—7% chromium-0.5% molybdenum
(5)—9% chromium-1.0% molybdenum

The five chrome-moly steels were announced at the API Symposium to bring them to the attention of refiners, and to secure discussion within the industry. They have also been put before PAD for its consideration. It is felt they will meet the needs of refiners for steels in which chromium and molybdenum are the only alloying elements used, although the upper limit of 9% chrome is under what some refiners are now specifying. The five grades are the selection of manufacturers' representatives as well as refiners on the committee, and they are grades which are available among a number of steel manufacturers. The proposed emergency standards were announced at the symposium by M. S. Northup, Standard Oil Development Co.

The Interim Committee next proposes to take up emergency standards for the austenitic steels, it was stated. These are steels containing 8-20% nickel along with higher percentages of chromium, sometimes up to 25%, and in some instances molybdenum. These steels are used where a combination of high temperature strength and good corrosion resistance is needed. B. B. Wescott, Gulf Research & Development Co., Pittsburgh, is chairman of the committee.

Suggestions were given at the symposium on ways in which refiners might help themselves in securing alloy steels in the critical months ahead. Among others was one that specifications include detailed descriptions of the end use of the material being ordered, so that metallurgical authorities with National Production Authority in Washington can use their experience in suggesting other steels if original specifications cannot be filled.

The information, as to end use of the steel, should specify the temperature, pressure and corrosion conditions which are to be met. Such complete information is also required by NPA in order to determine the melt schedules of the mills, it was stated. It was also officially said that orders will be given consideration by the steel producer only when such end use data is included.

"There are many instances in refineries," said R. M. Morrison, director of the Materials Division of PAD, "wherein a large percentage of high grade alloy steels are used where low alloy steels would be as suitable for the purpose. This is particularly true when alloy steels were specified some years ago for furnace tubes, piping systems, and exchanger tubes, and where the plant operations have changed or a new type of crude supply made available. Re-examination will show in many cases that lower alloy steels could be used.

"All refiners should review their alloy steel requirements both for new construction and replacements. The results will be dividends to the plants in the form of cost savings, as well as substantial savings in these critical materials."

Refiners were also asked to take into account in placing their orders for steel that there is a

disproportionately long "lead time" between the day alloy steels are ordered and the day these are produced for delivery by the mills. This applies particularly to orders for alloy furnace and exchanger tubes, tower linings and vessel internals.

In normal times it has usually been necessary to allow from 4 to 6 months "lead time" to secure deliveries on these items. Considerably more time should be allowed the mills under present conditions. Refiners are urged to take this factor into account in anticipating their needs for alloy steels containing nickel, molybdenum and or columbium.

Refiners could conserve in their use of the critical alloy steels by the greater use of carbon steel, Dr. Carl H. Samans, metallurgist, Standard Oil Co. (Indiana), told the conference. Carbon steel could probably be used without undue hazard up to 1,000° F., he stated, provided:

(a) only crudes of low corrosivity were processed,

(b) the steel was not exposed to deteriorating vapors, such as those high in hydrogen and or hydrogen sulfide, especially at high pressures, and,

(c) the structural deterioration of the steel during service did not lead to embrittlement or serious loss in ductility.

"It is true," Dr. Samans stated, "that thicknesses would have to be increased to compensate for the lower strength of the carbon steels in comparison with alloy steels, and much more metal would be required; were this the only difficulty it could probably be lived with." (Dr. Samans' complete discussion appears later in this article.)

N. J. Rees, Socony-Vacuum Oil Co., told the symposium that the committee working on the Oil Section of the ASA Code for Pressure Piping had recently decided to permit the use of carbon steel to 1,100° F., whereas it was previously limited to 1,000° F.

"The oil industry is in a unique position to utilize carbon steel at these high temperatures", Mr. Rees said, "because it has highly developed and efficient Maintenance and Inspection Departments which make thorough inspections of high temeprature equipment at regular intervals." (Mr. Rees' remarks also are given in detail later in this article.)

"Considerable publicity has been afforded the use of boron as an additive to steel," stated John J. B. Rutherford, Babcock and Wilcox Tube Co., Beaver Falls, Pa. "With medium carbon steels containing minor alloying additions, such as manganese, a very small addition of boron is effective in raising the strength properties at ordinary temperatures. This may offer some aid when tensile strength is the primary requirement."

# Some Problems Incident to Alloy Steel Substitution in Petroleum Refineries

By CARL H. SAMANS, Standard Oil Co. (Ind.)

*The following paper was presented at the Symposium on "Outlook for Steel" held Nov. 6 during the API annual meeting in Chicago.*

OF ALL the characteristics required in refinery steels, corrosion resistance is the most difficult one to evaluate. Although additions of chromium are known to increase resistance to oxidation and to corrosion by sulfur compounds, it usually is difficult to predict just how much chromium will be needed for any given application unless there is a background of directly related service experience.

Chromium also is of value in stabilizing the carbides which are found in most steels. This stabilizing effect serves to protect the carbides against attack by hydrogen, which will permeate and weaken the metal if it is in contact with hydrogen, or compounds containing it, under sufficient pressure. It also protects against graphitization, a decomposition of the carbides forming graphite in the solid steel, sometimes with significant loss in ductility. Generally the amount of chromium required for carbide stabilization is less than that required for corrosion resistance, so both needs can be taken care of adequately if selection from a limited series of alloys containing different amounts of chromium is possible.

For alloys containing up to about 10% chromium, the use of some molybdenum is needed to at least minimize the possibility of temper brittleness. Otherwise, at service temperatures near 1,000°-1,100° F., the steel will change in some manner with time, for reasons which are not entirely clear at present, and lose much of its ductility when it is subsequently cooled to room temperature. Hence, a tube that was satisfactorily ductile when installed could be almost glass brittle at the first shut down. The disadvantages of this are obvious so some molybdenum must be added to the alloy to correct it.

It must be emphasized that we know of no alloying element other than molybdenum and of no combination of elements that can be used instead of molybdenum to prevent this temper brittleness. Furthermore, we do not know what the minimum amount of molybdenum required to control temper brittleness is. It seems to be between about 0.25 and 0.5%, although considerable additional work will have to be done to fix this minimum closely enough for specification purposes.

Molybdenum also imparts high temperature strength, and resistance to creep and stress rupture. Although, in this respect, the element vanadium can be used as at least a partial substitute for molybdenum, limited data and little in the way of service experience are available as to its effectiveness. In addition, the availability of vanadium may be open to considerable question. Amounts of molyb-

## Meet the Author

Carl H. Samans is a chemical engineering graduate of Rensselear Polytechnic Institute and has done postgraduate work in metallurgy at Yale. He taught metallurgy at Rensselear, Lehigh and Pennsylvania State College. He also spent several years in metallurgical research for Chase Brass and Copper Co. and for the American Optical Co. He has been Associate Director of the Engineering Research Department, Standard Oil Co. (Indiana) since 1949.

Dr. Samans is the author of the textbook "Engineering Metals and Their Alloys" and of numerous scientific papers. During the war he was with the WPB Conservation Division. His petroleum refining background comes naturally as he is the son of Walter Samans, formerly with Sun Oil Co., who was for many years active in the work of API committees having to do with refining equipment.

denum up to 1.5% have been used for this strengthening purpose but generally the 0.5% alloys, with a few containing 1% molybdenum are used most commonly. Since, in this respect, the first 0.5% of molybdenum is a more effective strengthening addition than the second 0.5%, the 1% molybdenum alloys probably can be eliminated for the emergency period for most applications.

Certainly, therefore, because of its beneficial effects in increasing high temperature strength properties and in eliminating temper brittleness, some molybdenum must be used whenever a chromium steel is required. Exactly how much molybdenum should be used may be open to question at present but this can be answered only by study and experience. At present, no significant decrease in molybdenum content is feasible on any reasonable basis because neither laboratory data nor service experience is available for alloys containing less than 0.40% molybdenum.

**Nickel Needed for Strength**

When a combination of high temperature strength and good corrosion resistance is needed, the alloy steels containing 8-20% nickel along with 18-25% chromium, and sometimes up to 3% molybdenum, have been used in the past. The nickel is needed to give a type of alloy structure, called austenitic, which is inherently much stronger than the straight chromium or ferritic alloys. When requirements are this severe it may be possible to eliminate the molybdenum but not the nickel or chromium. Experience has shown, however, that general downgrading practices of industry probably will make the 20% chromium-10% nickel alloy more available than the 25-20 or 25-12 alloys. This 20-10 alloy should be satisfactory for most applications and it probably can even be used now with reasonable safety. Even though its specific properties are not too well known, enough information is known concerning older alloys which bracket it in composition to permit its use.

Columbium, one of the least available of our alloying elements, is also used for carbide stabilization but generally to minimize localized corrosion attack, usually corrosion by aqueous solutions, as it seems to impart little if any high temperature advantage. The substitution of titanium for columbium in wrought alloys should not introduce problems which cannot be handled. However, in cast alloys and in welding rods there is no known substitute for columbium at this time. Although some work is being done on extra low carbon stainless steel welding rod, this material cannot be considered as yet to be either completely available or satisfactory.

The manufacture of titanium stainless steel castings and the use of titanium stabilized welding rod has not proven to be commercially feasible thus far, largely because of segregation and of loss of titanium in melting. Hence, when stabilized stainless steel castings are needed, and this point should be subject to careful scrutiny by everyone in the industry, only the allocation of columbium or the successful development by the castings industry of a method for utilizing titanium stabilization can meet our requirements.

There is little doubt that, if all the needed information were available, significant conservation of alloying elements in steels used for refinery service would be entirely possible. In most instances, however, this needed information can be secured only by service experience. Since the same process in different refineries is seldom used to treat identical crude under exactly the same conditions, this service experience can only be secured by actually running a plant. Too often even supposedly conservative estimates of alloy needs have been shown to be too low by this practical method.

Up to 1,000° F. carbon steel probably could be used without undue hazard, provided:

(a) only crudes of low corrosivity were processed,

(b) the steel was not exposed to deteriorating vapors, such as those high in hydrogen and or hydrogen sulfide, especially at high pressures, and,

(c) the structural deterioration of the steel during service did not lead to embrittlement or serious loss in ductility.

It is true that thicknesses would have to be increased to compensate for the lower strength of carbon steels in comparison with alloy steels and much more metal would be required; were this the only difficulty, it probably could be lived with.

From a practical viewpoint, the surprising thing is that the industry has in the past required so little alloy steel rather than so much. Even this relatively small usage undoubtedly could be reduced still further if exactly the same type of plants were to be built in the future as we have now and if these plants were to be run on the same crudes. However, our industry is a highly competitive and progressive one. New processes are being developed constantly and must be developed to meet the demands which the automotive and aircraft fields, in particular, make upon us. In addition, it is probable that the corrosivity of crudes will increase steadily and that by-product recovery, which frequently means greater corrosion, will increase, if only to minimize possible atmospheric and water pollution.

**Basic Corrosion Data Lacking**

These new processes, new raw materials, and new chemical products raise questions concerning corrosion which cannot be answered without a considerable amount of experiment and study. The basic information needed for a rapid evaluation of corrosion problems is not available and not even pilot plant data can be relied upon unless these plants are larger and better prototypes of the final plant. The best that can be hoped for, therefore, is the use of good judgement by the technical men with the greatest exeprience. Their estimates must, of necessity, be somewhat conservative if only for the reason that, in times of emergency, plants are only constructed because their output is essential, usually to military rather than civilian operations, so the chance of a foreseeable failure cannot be too great.

Refining processes must be kept operating to be effective. Conservation of materials which jeopardizes the operation and output of the plant is poor economy indeed.

# Conservation of Critical Alloys

By N. J. REES, Socony-Vacuum Oil Co.

*The following paper was presented at the Symposium on "Outlook for Steel" held Nov. 6 during the API annual meeting in Chicago.*

OF ALL the industries, I believe it can be said that the oil industry utilizes carbon steel to the greatest possible extent. Generally, where alloys are substituted for carbon steel it is because of high temperatures or corrosion. It is universally recognized that properties of carbon steel such as creep strength, rupture strength and oxidation resistance decrease very rapidly at temperatures in the order of 1,000° F. By utilizing our knowledge of these properties, carbon steel may be used for many applications where on first thought alloy steels are chosen.

An important difference between carbon steel and the low chrome alloys is the welding properties. Whereas carbon steel is easily welded, the low chrome alloys require controlled procedures and where these procedures are not carefully carried out, cracks and failures may occur. This

characteristic makes the design engineer in the oil industry reluctant to use alloy steels unless he really has to.

The first example of the conservation of critical alloys by the oil industry is the fact that we continue to use carbon steel in the temperature range where graphitization occurs. In 1943 a steam line failed in the Springdale Power Station. If the non-return valve had not functioned, millions of pounds of steam would have escaped, probably completely destroying that station. This failure was due to the graphitization of carbon moly steel. Since that time, the power industry has gradually stopped using carbon steel at high temperatures so that now carbon steel is not generally used at temperatures above 775° F. In the oil industry, such a drastic decision was not made.

No major failures due solely to graphitization have been reported in the oil industry. Oil industry engineers have been cooperating with the ASME and the ASTM in attempting to determine the causes and methods of reducing graphitization. It is believed that the dangerous form occurs only in certain types of carbon steel and a strong attempt is being made to develop specifications for graphitization-resistant carbon steel.

### Carbon Steel Limit Now 1,100° F.

In connection with this situation, design engineers will be interested in knowing that the committee working on the Oil Section of the ASA Code for Pressure Piping, has recently decided to permit the use of carbon steel to 1,100° F. whereas it was previously limited to 1,000° F. Another item of interest is the fact that several months ago an ASA committee proposed to reduce the maximum allowable temperature of carbon moly steel from 1,100° F. to 1,000° F. Because of oil industry objections this was not done. It may appear paradoxical that the oil industry is raising the temperatures for carbon steel whereas the other industries are going the other way.

The oil industry is in a unique position to utilize carbon steel at these high temperatures because it has highly developed and efficient Maintenance and Inspection Departments which make thorough inspections of high temperature equipment at regular intervals. It is believed that no other industry spends so much time and money on inspection of equipment.

### Example of Substitution

I would now like to cite one example of the use of carbon steel at high temperatures in place of chrome alloys. In the Thermofor catalytic cracking units developed by Socony-Vacuum, the catalyst is transported to the top of the unit by means of a lift pipe. The temperature of the catalyst may be as high as 1,075° F. and the lift pipe is generally about 200 ft high. This lift pipe is very important since its failure would shut down the cracking unit.

At the time that these units were first designed, the question arose as to whether carbon steel should be used or 5% chrome. Some engineers felt that 5% chrome would be safer. In all except one job it was decided to use carbon steel, expecting that we would lose as much as ¼ in. in oxidation in 10 years. A number of these units have been operating for about a year and carbon steel has been successful. We have no information to indicate that the alloy resists abrasion caused by the catalyst stream any better than carbon steel.

My second example of the reduction of critical alloys has to do with the use of 19-9 chrome nickel versus 25-12 chrome nickel castings. The Thermofor catalytic cracking units referred to above have structural castings in the catalyst regenerators which are designed for 1,400° F., due to the fact that this temperature may exist locally. For many years, the analysis commonly used for heat resistant castings in the oil industry has been 25-12 chrome nickel. These have been used as tube supports in fired heaters and also in boilers. This analysis is resistant for temperatures up to 1,800° F. Since our temperature was only 1,400° F. we felt that a lower alloy might be satisfactory. It was found that of the whole industry, only one or two companies made a 19-9 analysis. However, there was little information available as to its strength at high temperatures.

Despite the lack of conclusive information regarding the high temperature properties, we decided to use the 19-9 castings and prepared our own specification covering them. Four of the largest foundries had never made such castings and some of these resisted our efforts to purchase them with the result that we installed 25-12 in some units and 19-9 in other units. However, our insistence on the use of 19-9 caused the manufacturers to make creep and rupture tests of this analysis. These castings have proven satisfactory in service and in the future, due to the critical nickel shortage, will be used generally for the conditions mentioned, thus conserving an appreciable quantity of nickel.

Another example in the conservation of critical alloys is the case of a pressure vessel operating at high temperatures. In one of the processes being developed by Socony-Vacuum, we have a reactor which operates at about 200 psi. and 1,100° F. This vessel has a diameter of about 10 ft. If made of 2¼% chrome, ½% moly steel it would be about 4¼ in. thick. Made of 18-8 chrome nickel steel it would be only 1⅜ in. thick.

### Internal Linings Not Satisfactory

Due to our desire to conserve critical alloys we investigated the use of an internal lining. Whereas internal linings are successful in cracking unit regenerators where the coke is burned, they are not completely successful in reactors since in these vessels coke is often deposited in the internal insulation reducing the insulating values and in time permitting the shell to heat up. In fact, one large manufacturer of insulating materials told us that they knew of no successful design for internal insulation of reactors.

To get around this difficulty we are at present planning to use a dense concrete as internal insulation with the thought that the coefficient of heat transfer of this material is so high that the deposition of coke could not appreciably increase it. By use of this lining, the shell temperature will be reduced to about 900° F. and can thus be made of 1¼% chrome, ½% moly steel, 1¼ in. thick. This design, together with the use of a few thermocouples on the shell, may prove acceptable.

## Meet the Author

N. J. Rees, of Socony-Vacuum Oil Co., has had a long-standing interest in the field of metals. He was graduated by the College of the City of New York in 1931 with a B.S. in 1931 and an M.E. in 1932. For 6 years he worked with the U.S. Navy Dept., for several years in the power industry, and for 3 years with M. W. Kellogg Co.

He joined Socony-Vacuum in 1944, and is now development engineer in the refinery engineering division. He is also chairman of the Subcommittee on Unfired Pressure Vessels of the API Refining Division's Committee on Refinery Equipment.

No. 6 in a series on How to Order Equipment

# How to Get What You Need When You Order Compressors

*By D. P. THORNTON, Jr., Southwestern Editor*

THERE are a multitude of jobs which compressors must handle in the processing branch of the petroleum industry. They will be found in refineries, natural gasoline plants, chemical manufacturing, cycling operations and the like.

They may be called upon to handle almost any gas from air to ammonia, chlorine, gaseous hydrocarbons and chemical vapors, working under a variety of conditions. An installation may cost anywhere from less than $100 to several thousands per unit, which makes the matter of securing the right compressor for a given job worthy of considerable care when ordering a new one or repair parts.

Only the relatively small and simple air compressors, such as the fractional horsepower designs used in spray painting for the home workshop, and the somewhat larger ones used in service stations and the like, are readily obtainable as catalog items. Ratings exceeding about 15 BHp. for any service, and even the smaller sizes in complex applications, generally cannot be purchased other than direct from the manufacturer.

This develops because the application and design of the compressor is not a simple matter; oftentimes, too, the manner of installation itself may spell the difference between satisfactory and unsatisfactory performance. The design problems are very similar to those encountered with a two-cycle internal combustion engine because both compress a gas; the principal difference is that an engine also produces power while a compressor consumes it. As with any engine, indicator cards may be used to predict compressor performance and power consumption.

Compressor manufacturers in general report two principal difficulties in securing adequate information from purchasers. These are inability to supply certain technical information and a tendency toward indefinite design values for suction and discharge pressures, particularly in natural gasoline plants.

In few cases do customers deliberately refuse technical information in their possession. Generally it is a case where the buyer did not know the information was needed and why. Hence he made no effort to determine it and may lack the knowledge to develop it from available information. Generally engineering contractors do a good job in presenting adequate inquiry data, probably because they do it more frequently than the usual customer who buys compressors directly.

**Data on Gas Analysis Vital**

For example, the composition of the gas is vital in designing any compressor.

The ratio (variously termed "N" or "K") of the specific heat at constant pressure to that at constant volume is required to determine the horsepower needed. For dry air this value is normally 1.406, but for other gases it must be computed as a weighted value on the basis of the mol-% composition of the mixture. In some cases, where pressures are extremely high and temperatures extraordinary, suitable adjustments in specific heat values must be made.

## *What Other Equipment Do You Order?*

This current article on compressors concludes the present series on "How to Order Equipment." The first two articles covered valves; succeeding ones dealt with pumps, heat exchangers and instruments.

What other items of equipment would you like to see covered in similar articles in the future? Send your suggestions to:

The Editor
PETROLEUM PROCESSING
1213 West Third St.
Cleveland 13, Ohio

If, for some reason, the customer finds it undesirable to disclose the nature of the gas, then either the design specific heats or "N" value must be furnished on his sole responsibility.

The presence of olefins and other unsaturates, if present in sufficient quantity and always a factor in refinery gases, may have considerable effect on the tendency toward polymerization under the conditions of compression or the possibility of decomposition. Hydrocarbons heavier than $C_5$ will have a considerable effect on the "N" value if present in large proportion; this is usual in refinery gases.

Another situation compressor builders have to contend with is the processing of a gas between compression stages. In such cases, the manufacturer must be given not only the absolute pressure and temperature at which gas is returned to the next compression stage, but the new composition. In effect, if there is any radical change in the "N" value of the returned vs. the original gas, the compressor actually is being used for two separate services and must be designed accordingly.

Another important use of the gas analysis is in determining "trim" for the compressor cylinder, piston and valves when known corrosives are present. Gasket material also may be affected. The manufacturer may be able to arrange for injection of flushing oil or other fluid in the gas to be compressed to mitigate corrosive effects. With certain gases, ordinary oil may not be used for lubrication and a non-lubricated design must be furnished handling chlorine or oxygen, for example.

In justification to natural gasoline plants being constructed in new areas, compressor manufacturers realize it may not be possible for their designers to supply a precise analysis of the gas which actually will be processed by the finished plant. Fortunately a considerable change in composition of the average wet natural gas, below methane and ethane, will affect but little the "N" value used for compressor design. In turn, and depending on the actual circumstances, this may or may not change compression characteristics greatly. However, when it does, manufacturers feel their customers should be equally understanding.

### Common Faults in "Specs"

One of the most common faults in the orders which compressor manufacturers receive is statements like: "suction pressure to be so many pounds per square inch or pounds at 'standard conditions.'" Designers must have the absolute pressure at some stated temperature. Unfortunately, the woods are full of allegedly "standard" conditions. Consequently, just stating "standard conditions" is pretty much meaningless unless your compressor supplier has dealt with you before (and probably wrote or phoned you the first time to find out what you meant).

On top of this, a gage pressure may have been taken without consideration for the prevailing barometric pressure and perhaps the altitude. In consequence, perhaps the compressor manufacturer may be forgiven for muttering "SNAFU" when the barometric pressure, absolute pressures or location do not appear in specifications.

Compressor manufacturers believe their customers could save considerable money by being more careful about insisting on variable capacity provisions and pressure flexibilities. These always appreciably increase the cost of a compressor, even when the clearance pockets or other arrangements are to be added later. For instance, in ordering a compressor to discharge at 800 psia. now, and capable of discharging at 1000 psia. later, so far as the maunfacturer is concerned, pressurewise the design is for 1000 psia. *now*, with provision for subsequent installation of cylinder unloading facilities when the higher pressure is required.

It is believed that in actual practice many customers never use these flexible provisions to the fullest extent. Perhaps the greatest additional cost is involved in a wide range of suction conditions. Suction pressure has more effect on horsepower than any other design factor. The narrower the range, the less will be the original cost and the least complicated will be the cylinder design. A wide range may even force a provision for another compression stage or some other load-balancing means, assuming discharge pressure is not to vary, since most manufacturers do not like to go above a compression ratio of 5:1 per stage and prefer 2:1 to 3:1 for gas service.

The matter of compression ratio is something which definitely should be left to the manufacturer's option. He will base his selection primarily upon mechanical conditions, although the proportion of heavy components in the gas will have a bearing on this.

A matter which causes much sub-rosa profanity among compressor manufacturers is the apparent inability of buyers to make up their minds on suction and discharge pressures. Changing the volume to be handled is not so difficult, because this usually will be great enough one way or the other to be taken care of by increasing or decreasing the number of units required. But, particularly when suction pressure is appreciably changed, in all likelihood the designer must forget his previous calculations and start all over again. Imagine the reaction of an operating foreman were he ordered to run 30% more gas through his plant without changing the size of any equipment.

Occasioning almost as much hair-tearing in designing an air-compressor or internal combustion engine to drive a gas compressor is to have no location given; therefore sea-level is assumed. Afterwards the designer is told the machine will be run at altitudes above 1500 ft., whereupon his opinion of your ancestry becomes unprintable. At an altitude of 3500 ft. above sea-level, or about that of Amarillo, Texas, an engine must be de-rated nearly 10% below name-plate rating because air pressure is about 1.9 psia. less than the usual 14.696. A similar effect occurs with air compressor suction. This is why the manufacturer wishes to know where the machine will be located and, if the specifications give only gage pressures, he can at least get in the ball-park in estimating the probable absolute pressures for design.

Compressors have been designed to use almost every known type of prime mover; generally the manufacturer has no preference. In the oil industry, the most common drivers are electric motors; steam engines and turbines; gas, gasoline, dual-fuel and Diesel engines.

Drivers often are equipped with various types of special controls to suit the particular needs of the individual buyer. They may range from the simple start-stop pressure switch of the familiar service-station compressor to the often-elaborate automatic controls of an unattended gas pipe line compressor station. Practice varies on whether these controls are furnished by the customer or the manufacturer as auxiliaries.

Compressor manufacturers generally prefer to furnish the drivers for their compressors when the driver is not integral. This develops from the fact that certified dimensional prints of the particular driver are necessary in fabricating the mounting arrangement to be used, regardless of who supplies the driver. Also, dimensions for the driver shaft, details of keying, and coupling arrangements are needed.

When the buyer furnishes the driver he should arrange at the time the order is placed to furnish the compressor manufacturer with certified prints covering these various details. Because often these details are overlooked with buyer-furnished drivers, the compressor delivery may be delayed; meanwhile much correspondence and telephoning is probable. It is no wonder, then, that the compressor manufacturer prefers to handle the matter himself.

The buyer should advise the compressor manufacturer how many certified prints of the entire unit he will require, including appropriate instruction books and parts lists.

### Purchasing Suggestions

Several manufacturers particularly urge their customers not to demand that accessories like lubricators, ignition systems, mufflers, intake filters and so on be of a certain make or size, especially when a particular make is not standard with the manufacturer. There are good reasons for this.

The manufacturer already has arranged his source of supply and usually has in stock the types and sizes to fit his equipment. If he is forced to go "outside," deliveries are almost certain to be delayed. Moreover, if he is unfamiliar with a certain item, he should not be expected to guarantee its performance with his equipment. Finally, since his designs and manufacturing operations are predicated on his standard accessories, it is quite likely that mounting provisions and other mechanical factors may have to be altered. This again spells delayed delivery to the customer.

Sometimes these requirements are capricious. This is illustrated by the experience one manufacturer had with an oil company. The specification called for a certain size and make of engine exhaust silencer, an item which was not designed for the application in question. Pressed for the reason why the manufacturer's standard was not acceptable, the company replied to the effect that once such a silencer had "blown up" unaccountably, and therefore was permanently banned.

Another suggestion involves the matters of foundations upon which the compressor and generally the driver are to rest, installation of the unit, and the piping arrangements. None of these are involved in manufacturing the compressor. However, the manufacturer not only is interested in selling a compressor, but he wants it to give satisfaction both in operation and maintenance.

Therefore, he is willing to make suggestions as to the foundation design, and on request supplies details as to magnitude, frequency and direction of unbalanced forces. He will not design foundations, however. He also will make recommendations on the layout of the building in which the compressor will be installed. Most manufacturers will furnish installation supervision upon request and some include the cost of this service as a separate item in quotations.

The manufacturer is extremely concerned with the piping arrangements conveying gas to and from the compressor. Satisfactory performance stands or falls on whether or not piping is properly arranged and of correct size. Consequently, most performance guarantees are based on what the manufacturer considers to be "normal good practice" in piping layout.

Moreover, if pipe vibrates excessively or is improperly supported, strains may develop which will damage the compressor or contribute to excessive maintenance. The manufacturer will neither design nor install piping, but

he certainly will make well-considered recommendations. Remember, he has seen many compressor installations whereas the customer generally is familiar only with his own.

Surprisingly enough, most post-installation complaints that a compressor is "no damn good" come from refiners rather than natural gasoline or cycling plants and gas pipe lines. Such complaints usually can be traced directly to poor maintenance or bad operation, manufacturers aver.

This apparently stems from the fact that in refineries no single man or crew is permanently assigned to compressor maintenance and, unlike gasoline plants, compressors in a refinery usually are not considered one of the most vital parts of the plant. Then, too, personnel change frequently and the men do not have time to become first class operators or adequately skilled in compressor maintenance.

One compressor manufacturer's representative flatly told the author that, in a refinery, "the machines are dirty outside and dirtier inside all too often; the smaller the refinery, the worse the condition." This, he believes, is at least a partial reason why refineries are tending more and more towards installation of centrifugal type compressors instead of the reciprocating types—less maintenance and operator attention is required.

However, this is no general solution, for there are many services in which a centrifugal compressor is inapplicable or uneconomic. Compression ratios generally are low per stage; usually less than 2:1. The volume handled in order to be economic must be large since these machines are exceedingly expensive in small capacity sizes. Consequently, in the usual natural gasoline plant volumes are not large enough and the overall compression ratio involved


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is too great (complicated by sealing problems at high pressures) to favor all-centrifugals over reciprocators.

While it is not the purpose of this article to attempt to suggest the type or size of compressor to be used in any application, it is emphasized that selection of any compressor should be made only after detailed study of all aspects of the proposed application. To do this, adequate data are needed by the manufacturer.

## Data required when ordering compressors

The information to follow which the customer should furnish in requesting quotations or placing orders for compressors is based on the requirements of many individual compressor manufacturers and applies regardless of service. The data are equally suited to ordering both reciprocating and centrifugal compressors. In connection with the cooling equipment for gas, jacket water and lubricating oil, incidently, the reader is referred to the fourth article in this series (PETROLEUM PROCESSING, Oct., p. 1128) for information to be supplied when this equipment is ordered separately from the compressor.

**COMPRESSORS ONLY**

1. Installation.
   a. Type of operation. (E.g., continuous or intermittent duty; refinery gas recovery, gasoline plant, pressure maintenance, gas pipe-line, gas booster station, plant air, instrument air, etc.)
   b. Geographic location and altitude (or prevailing barometric pressure).
   c. If adding to an existing compressor installation, state manufacturer, type, model, and size for this equipment. (Manufacturer may be able to size units so as to cause the least increase in spare parts inventory; also gives good idea of available utilities and service conditions.)

2. Gas handled.
   a. Name and composition. (Give analysis in mol-% unless gas is air or a pure, well-known material for which thermodynamic data are readily available. Details on minor constituents are not important unless corrosive. Presence of unsaturates should be shown separately from saturates and quantities of $C_4$ and heavier hydrocarbons should be given accurately. Do not present data in mols per day.)
   b. Quantity to be handled. (MMcfd., Mcfd., cfd., cfh., cfm., at a specified temperature and pressure base. Preferably pressure should be absolute. Capacity ratings generally are referred to intake conditions; gas compressors in Mcfd. at 14.4 psia. and some design suction temperature compensating for normal annual variations.)
   c. Presence of corrosives and solids.
      1) State nature of any corrosives known to be present, giving details on uncommon materials and suggest resistant materials if known.
      2) Specify if gas is dirty or liquids apt to be present. (Manufacturers generally assume gas has been scrubbed, separated and filtered.)
   d. Suction conditions. (Exerts most effect on horsepower requirements per MMcfd. Most severe condition expected will be used for design.)
      1) Pressure. (Preferably absolute, under flowing conditions at inlet flange. If range given, make it as narrow as possible.)
      2) Temperature. (Close estimate of average at inlet flange. Unusual condition will be compensated for in design.)
      3) If variable pressure anticipated, state:
         a) Present. (Include daily variations.)
         b) Anticipated ultimates, by years if feasible. (Aids in determining most economical design arrangement for operating flexibility, such as adjustable pockets, clearance rings, etc.)
   e. Discharge conditions.
      1) Final pressure, psia. or psig. (If suction conditions are variable, advise if this can be allowed to affect discharge pressure. If variable discharge—especially if to be higher in future operation—is desirable state details, by years if feasible.)
      2) Interstage pressure(s). (Specify only when a fixed interstage discharge pressure is required for process purposes. Advise also the pressure drop across this part of the process and temperature of the returned gas. If a marked change in composition occurs, give the "new" composition or "N" value to be used.)

3. Compressor Equipment.
   a. Kind of compressor. (Blower, centrifugal, reciprocating, etc. Usually also indicates whether driver is integral or separate from compressor.)
   b. Number of units preferred. (May be left to manufacturer's option.)
   c. Suggested horsepower (size) of individual units, if known or have preference.
   d. Standby capacity: (If desired. Express as per cent of basic capacity or as number of units of designated horsepower.)

4. Cooling equipment. (Ordinarily not furnished by manufacturer except intercoolers for air compressors. It is strongly urged that customer *not* place orders for coolers until compressor manufacturer determines volumes and cooler inlet temperatures and pressures. In ordering, see data required for ordering heat exchangers, Article 4 this series, October 1951 issue, pp. 1128-32.)
   a. Cooling water supply.
      1) Type of cooling water system installed. (Spray pond, cooling tower, air-cooled exchanger, etc., and is water raw, fresh, salt, treated, etc.)
      2) Average maximum water temperature (summertime).
      3) Volume available (gpm) for compressor cooling services; gas engine also, if to be used. (Note: Most manufacturers strongly recommend closed jacket water systems.)
   b. Stage intercoolers. (Specify only when gas is processed between compression stages. Manufacturer will advise if intercooling required, but must know extent to which installation can support cooling facilities.)
      1) Anticipated pressure drop (maximum) across each. (Keep as low as practical; usually 3-5 psi.)
      2) Intercooler gas outlet temperature, each stage.
   c. Oil cooler. (Applies only for special cases and large machines.)
      1) Specify if manufacturer to furnish; be sure information under 4a, above, has been given.
      2) If customer to furnish, advise lowest maximum oil outlet temperature expected, bearing in mind most manufacturers prefer oil inlet (to engine) temperatures in the range 130° to 145° F. If air cooler to be used, advise design maximum summer air temperature.

5. Controls. (These generally include unloading controls for ease in start-up, pressure-actuated governors or other means for guarding against excessive discharge pressure or excessive speed, plus other special controls specified by customer. These are in addition to safety

controls normally included with compressor, such as lube oil pressure failure, overspeed, excessive jacket water temperature and the like; manufacturers' practices vary.)

6. Auxiliary equipment. Include under this heading preferences in intake filters, silencers, lube oil filters, lubricator system, cooling water pumps, aftercoolers and the like. Avoid specifying sizes, as these will be selected to best suit the unit.

7. Engineering information required of compressor manufacturer. (Specify *only* those items to be required when compressor is furnished. Such data ordinarily do not accompany quotations but extra charges involved will be included, often as a separate item.)

a. Unbalanced force diagram. (Number required. Used in foundation design. May involve extra cost.)
b. Inertia force information. (May involve extra cost.)
c. Number of prints for compressor and/or driver, parts lists, instruction books, etc. (Manufacturers' standard practices vary as to number of these items supplied without extra charge, especially when, in turn, they must be secured from other manufacturers, as in the case of drivers, special controls and the like.)

**DRIVERS ONLY**

1. Type of drive. Specify:
a. Direct-connected. (Also type of shaft coupling if applicable and not left to manufacturer's option.)
b. V or flat belt. (Advise if location is hazardous.)
c. Chain.
d. Gear.

2. If manufacturer is to supply driver, specify:
a. Electric motor.
1) Power characteristics (AC or DC, voltage, cycles per second, power factor).
2) Motor characteristics. (I.e., synchronous, induction, etc. Advise exciter voltage and power factor desired for synchronous motor.)
3) Controls and switchgear (when furnished).
4) Electrical code. (NEMA Code or advise splash-proof, explosion proof, etc.)
b. Steam drive.
1) Reciprocating engine or turbine.
2) Quantity available, lbs. per hour.
3) Characteristics. (Pressure, quality or superheat.)
4) Exhaust pressure.
5) Any other special specifications required by buyer. (Note: For turbines, if low steam consumption—water rate—is desirable even at increased driver cost, be sure to state this fact. When special turbine construction is required, such as steam inlet, steel; discharge or low pressure end, cast iron, etc., so state. Also note that most manufacturers normally include price of speed reducer in price of turbine.)
c. Engine drive. (Data needed apply whether engine is integral with compressor or separate.)
1) Fuel available. Specify by name and preferably give analysis if different from gas compressed; if unavailable, give heat value—Btu per cu. ft., lb., or gal. Avoid corrosives.
2) Fuel pressure, if gas.
3) Altitude (if Item 1b. for compressors was omitted).
4) Temperature of cooling water and quantity available. (Omit if given under Item 4a for compressors.)
5) Controls required (in addition to those built into driver).
6) Accessories. (Includes air cleaners, mufflers, oil filters, etc., when not regularly furnished. Do not specify sizes.)
d. If buyer is to supply driver advise:
1) Make, model and kind of driver to be used. (Including speed reducer.)
2) Horsepower and shaft size.
3) Speed.
4) Direction of rotation.
5) Whether to be mounted by buyer or compressor manufacturer. (If former, be certain to supply information requested under Item 1, Drivers, including applicable specifications if a chain or gear drive.)
6) Certified dimensional drawings. (Information needed for compressor foundation drawings, bed plate drilling, sheave boring, etc. *Omit* for inquiries.)
e. Engineering information required for drivers furnished by compressor supplier. (Same as Item 7, Compressors.)

## Data required when ordering repair parts

Far less information is required to order parts for compressors and integrally-built drivers than to adequately specify a new machine.

The majority of compressor manufacturers keep accurate factory records of all except the small compressors, like those which can be bought from Sears-Roebuck. These are variously arranged, but in general they are arranged by customer's name, geographically by plant, and keyed to model and serial number. Branch offices usually have duplicate copies of this information; restricted, however, to the area served.

Manufacturers customarily furnish parts books for each model of compressor they make. These contain reference drawings, parts numbers, catalog numbers and the like for a given range of serial numbers.

However, the biggest headache in this respect is the common tendency in parts orders to omit serial numbers and use the nomenclature applied in a given plant. Plant names often differ from manufacturer's nomenclature. When the order does not state serial number, then parts identification—following the style of designation used by a specific manufacturer—supplying a part is impossible.

Do not use the word "set" unless unavoidable for valves, rings, and so forth. Specify the number required.

The information usually required includes:

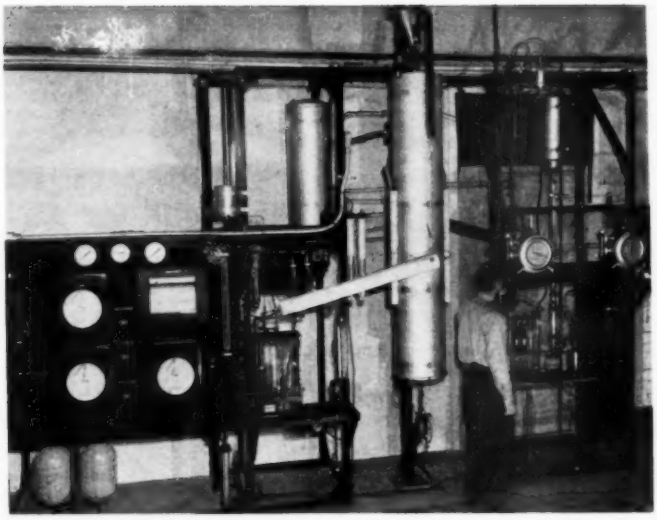
1. Model and serial number of the compressor. (From machine name plate.)

2. Compressor cylinder involved. (First, second or third stage or manufacturer's specific designation if two or more cylinders are paralleled in a single stage.)

3. Part description. See parts book for specific manufacturer's ordering instruction.
a. Quantity.
b. Part name. (Be sure to use manufacturer's nomenclature; *don't* call it a "gimmick".)
c. Applicable parts book drawing number.
d. Item number.
e. Catalog number.

4. If driver is integral with compressor and driver part is wanted, state portion of driver involved (often by compressor cylinder number) and proceed as in Item 3, above.

5. If driver is separate from compressor a separate part book will be furnished and parts should be ordered from driver manufacture, direct. Always be sure to give model and serial number of the *driver*.



**PILOT PLANT FLUID CRACKING UNIT** used by Tide Water. Left to right: instrument panel, cracking unit proper, and product stabilizer

# Midget Cracker Helps Big Brother

## Lab size unit assists refiner raise gasoline yields through constant, careful check on process variables

**By C. K. VILAND**
***Tide Water Associated Oil Co.***

A MIDGET fluid catalytic cracking unit is a very useful means for duplicating full-scale operations of this process in the refinery laboratory.

A tiny pilot plant of this type[1] has been in successful operation for more than two years now in Tide Water Associated Oil Co.'s Western Division Research and Development Laboratories. A generally similar unit was described recently by Grote and Hoekstra.[2]

The Tide Water equipment has proved particularly valuable in examining variables in processing, and in the comparison of feed stocks and catalysts. Proper evaluation of these factors have permitted greatly increased throughput and gasoline productivity in the refinery catalytic cracking facility at Associated, Calif.

For example, taking the results for the first seven months of 1947 as a base representing normal peacetime operations with the refinery's Fluid cracking unit substantially as originally designed, a comparison shows that the rate of production of catalytic gasoline fractions during July, 1950, was 81% higher. This kind of improvement is attributed mainly to better spent catalyst stripping, improvements in regeneration which have resulted in greater capacity, and the selection and proper use of more efficient catalysts. Better fractionation and improved handling of feed stocks were also factors, even though the present charge is heavier.

The midget laboratory unit has all the advantages of larger catalytic cracking pilot plants insofar as control of variables and reproducibility of data are concerned. Only small amounts of charging stocks and catalysts are needed. It has its own product stabilizer which reduces laboratory testing of products to one liquid and one gas sample. This simplifies yield calculations. Techniques have been developed so that it is normal practice to start up, reach equilibrium operating conditions, obtain samples under test, and shut down—all within normal daylight working hours. Operating manpower requirements are at a minimum: a two-man team controlling the unit as well as handling the compilation of test data.

### Description of Apparatus

In constructing the laboratory unit, the regenerator and reactor were sized to permit cracking of heavy California oils over a wide range of conversions. This requirement made it necessary also to maintain a proper temperature gradient in the feed line. The size of the pilot plant is such that it operates on only $2\frac{3}{4}$ lb. of catalyst.

Oil feed rates can be controlled through a bellows type pump in the range of 100 to 1100 ml./hr. depending on the space velocity desired, but most tests require charge rates of 150 to not over 600 ml./hr. A special single-shot piston pump was designed and built to inject distilled water for stripping steam controlled accurately at desired rates between 10 to 70 ml./hr.

Regeneration air is controlled manually from a constant pressure source and is measured through a rotameter. Rates are typically in the order of 15 cu. ft./hr. Nitrogen is used as the medium for lifting spent catalyst in the single lift line from the stripper into the regenerator feed hopper. For this, about $3\frac{1}{2}$ cu. ft./hr. is required.

The essential parts of the midget unit are four vessels superimposed vertically. Three of these are surrounded by electrically-heated elements in a refractory lined radiant furnace jacket assembly. At the bottom is the catalyst lift unit, and at the top is the catalyst hopper vessel. From the top down within the jacket are the regenerator, the reactor and the stripper. Temperature in each section of the refractory jacket is on automatic control. Catalyst is held at a predetermined level in each of the process vessels as it flows downward by gravity from the

upper hopper. The hopper, regenerator and reactor each are equipped with miniature cyclone separators, and in addition the regenerator and reactor have enlarged sections to help disengage gases and vapors from the catalyst. This reduces the cyclone loading.

All of the vessels and lines are fabricated from type 347 Columbium stabilized stainless steel because of its resistance to scaling at operating temperatures of 900-1100° F.

Initially, the unit was operated with the feed line inside the furnace assembly. On heavy stocks this proved to be a continual source of trouble due to coking, so the line was moved to an outside position and fitted with a 1000-watt heater. The matter of preheat is critical in achieving smooth operation, as too low temperatures will result in catalyst flow difficulties. In order to prevent agglomeration of the catalyst particles from liquid oil droplets, or upsetting temperature conditions in the vessels, it was found necessary to bring the oil up quickly to approximately reactor temperature, reaching the maximum just at the point it enters the vessel. This is accomplished by proper spacing of the heating element wires.

To obtain satisfactory gravity flow through the small lines and vessels, regular fluid catalysts must be screened to a particle size range of 60 to 150 mesh. With this coarser fraction, considerable difficulty has been experienced from particles becoming electrostatically charged and losing the characteristics of a fluid.

To alleviate the condition, the carrier nitrogen is bubbled through water before entering the lift jet. An electric vibrator and a rapper device are attached at the bottom of the vessel assembly to reestablish catalyst flow should momentary stoppages occur. A thermocouple on the catalyst lift line indicates temperatures which can be correlated with actual catalyst circulation rates. To check circulation, the catalyst flow is periodically diverted from the hopper inlet by a three-way cock at the top into a sample cup where it can be weighed.

Operating pressures are slightly above atmospheric. The back pressure on the reactor is due entirely to the effect of the product dehydrator and the debutanizer columns. To avoid gradual building up of back pressure from carry-over of small quantities of catalyst, the product line is of ½-in. pipe and is installed with a 12° slope. This line is electrically heated up to the dehydrator inlet.

Condensed water from stripping steam is separated from the product in the dehydrator column. This is packed with stainless steel helices. All the water and some of the gasoline is vaporized at this point. Most of the water is condensed as it passes upward and is collected in a trap. This is automatically drained so as to maintain a constant level. The reboiler at the bottom is equipped with a similar broken-syphon type of level controller. Water fog in the uncondensed vapor is removed in a five plate bubble column, and the gases further dried in passing through a calcium chloride tube. These uncondensed vapors and the water-free liquid product from the dehydrator reboiler flow by gravity into the debutanizer at its middle section. This column is filled with glass helices. Its reboiler is controlled by instrument at 175° F. and the refrigerated overhead condenser is held at 10° F. Under these conditions the gas product is essentially free of pentanes and the liquid synthetic crude withdrawn on level control from the reboiler contains substantially no butane fractions.

### Operating Procedure

After bringing the vessels up to operating temperature and with air going into the regenerator, and nitrogen into the reactor, stripper and lift jet, the full charge of catalyst is poured into the hopper. About ten minutes later the lift jet is adjusted to start the catalyst circulating. The air rate to the regenerator is raised to the normal rate of about 15 cu. ft./hr. Simultaneously, the product handling system with oil in it from the previous run is brought up to temperature.

When the reactor feed line reaches 850° F. the charge pump is started and as soon as oil vapors start leaving the reactor, the reactor nitrogen is shut off. The water pump is then started and the stripper nitrogen shut off. The unit is allowed to run under the desired operating conditions for about four hours to completely flush out the product system before taking samples.

During the sampling period of about three hours, the amount of oil charged is recorded. Flue and product gases go through wet test meters, and the synthetic crude is run to a flask for measurement. A composite sample of the product gas is taken for mass spectrometer analyses, and the synthetic crude is fractionated for its gasoline content. A composite sample of flue gas is analyzed in an Orsat apparatus to obtain the amount of catalyst deposit. Three sets of spent catalyst and regenerated catalyst samples are drawn for carbon analysis during the run, and the catalyst circulation rate determined so as to check the calculation of the coke burning rate.

At the end of the run, the charge pump is stopped and the product line by-passed into the blowdown system. Nitrogen is bled into the reactor and stripper after the feed and water pumps are shut off. There are inlets provided on both ends of the feed line for nitrogen or air purges. The upper one is used first to prevent a sudden surge of oil into the reactor. Oil in the feed line is drained and the nitrogen purge started on the lower inlet. After the reactor is purged of oil and the catalyst drained from the unit, nitrogen in both the reactor and stripper is replaced with air. Temperatures on the feed line, reactor and stripper are raised to 1100° F. or higher for a few minutes, and any coke deposited in the equipment is burned out. Heat is shut off at all points except the jackets surrounding the regenerator, reactor and stripper, which are held overnight on automatic control at 750° F. to speed the warm-up period the next day.

Data from each run are recorded on standard forms. For each comparative test about three runs are made at different conversion levels by changing the space velocity. After the essential data are plotted, comparisons may be made at any conversion, percentage yield of catalyst deposit, or other desired parameter.

### Type of Research

The unit has been used to evaluate all types of feeds ranging from light gas oil to the normal commercial vacuum distillate charge stock of about 21-23° API gravity, and on down to heavy coke still distillates, lube extracts and deasphalted residua. It has also been used to study most of the commercially available fluid cracking catalysts, microspheroidal and ground, both fresh and aged. A considerable range of operating variables also has been explored in the laboratory unit.

Operating temperatures, catalyst to oil ratios and other variables are usually set at values close to commercial practices.

The midget fluid catalytic cracking unit checks the refinery unit remarkably well. However, largely because no slurry oil is returned to the reactor, the small unit consistent-

## Meet the Author

**C. K. Viland** has been general supervisor of research and development of the Western Division of Tide Water Associated Oil Co. for the past four years. He is a graduate of the Colorado School of Mines, and has been with Tide Water since 1929. He is located at their Avon refinery in the San Francisco Bay area.

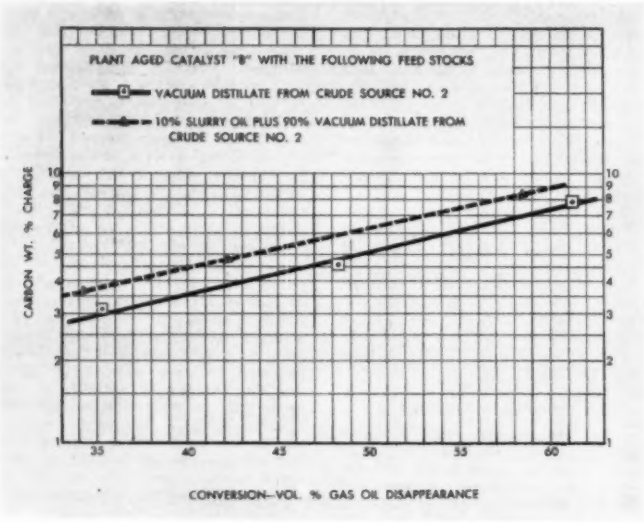



**FIG. 1**—Carbon vs. carbon conversion in midget cracking unit

## Table 1—Comparison of Commercially Aged Catalysts in Midget Fluid Pilot Plant—Feed Stock and Operating Conditions Constant

| | Catalyst Data | | | | |
|---|---|---|---|---|---|
| Type | Natural "A" | | Natural "B" | Synthetic "C" | Synthetic "D" |
| Base | Montmorillonite | | Halloysite | Silica-Alumina | Silica-Alumina |
| Activity—UOP Weight | 23 | 22 | 16 | 21 | 34 |
| Specific Surface—Sq. m/g. | 114 | 110 | 51 | 82 | |
| Type of Feed During Aging | Heavy Calif. | Heavy Calif. | Hvy.W.Tex & So.Amer. | Heavy Calif. | Mid Cont. Gas Oil |
| Replacement Rate During Aging—Lb/Bbl Feed | 1.08 | 1.94 | 84 | 0.17 | 0.34 |
| | Product Distribution | | | | |
| Conversion—Vol. % | 42.4 | 44.0 | 49.4 | 45.6 | 54.0 |
| Total $C_4$'s | 5.0 | 5.1 | 8.4 | 6.9 | 11.2 |
| Debutanized Gasoline | 33.6 | 35.6 | 38.1 | 32.2 | 39.2 |
| Total $C_4$—390° F. @ 90% | 38.6 | 40.7 | 46.5 | 39.1 | 50.4 |

Note: Above comparison is made at 5 wt. % catalytic carbon burn-off, with reactor temperature maintained at 950° F. in all cases. Feed stock properties are shown in Table 2.

## Table 2—Properties of Feed Stock

(As Charged to Pilot Plant in Table 1)

| Source | Heavy Calif. | Naphthenic |
|---|---|---|
| Gravity—° API | | 20.5 |
| Vacuum Dist. (Corrected to 760 mm.) | | |
| IBP—° F. | | 463 |
| 10% | | 662 |
| 50% | | 758 |
| 90% | | 878 |
| Viscosity—S.S.U. @ 100° F. | | 273 |
| Aniline Point—° F. | | 151 |
| Pour Point—° F. | | 75 |
| Carbon Residue—° F. | | 21 |
| Sulfur—Wt. % | | .80 |
| Nitrogen—Wt. % | | .31 |
| Ash—Wt. % | | .004 |
| Nickel—Wt. % | | .000065 |
| Vanadium—Wt. % | | .00011 |

## Table 3—Properties of Feed Stocks and Slurry Oil

| | Virgin Feed | Clarified Slurry Oil | 10% Slurry Oil 90% Virgin Feed |
|---|---|---|---|
| Gravity—° API | 20.5 | 16.7 | 20.1 |
| Vis.—S.U. @ 100° F. | 273 | 133 | 248 |
| Carbon Residue Wt. % | 0.21 | 1.45 | 0.37 |
| Vacuum Dist. (Corr. to 760 mm.) | | | |
| IBP—° F. | 463 | 514 | 487 |
| 10% | 662 | 674 | 673 |
| 50% | 758 | 766 | 776 |
| 90% | 878 | 890 | 876 |

ly produces about 10% less carbon than obtained commercially, and a factor is applied to this value in predicting refinery results.

Some typical data from recent investigations are included herein as examples of the versatility and practical value of a midget catalytic cracking unit in the laboratory.

### Comparison of Catalysts

Table 1 shows a comparison in the pilot plant of five commercially aged catalysts of various types using as a common feed stock a heavy California vacuum distillate with properties as in Table 2. Later, in commercial operations when catalyst of the type designed as "A" was changed over to that under heading "B", with replacement rates substantially as indicated, product distribution and gasoline yields were found to be closely in line with pilot plant predictions. A relatively high replacement rate is required with this California feed stock to maintain satisfactory product distribution because of an appreciable content of heavy metallic compounds.

### Comparison of Feed Stocks

The equipment also is useful in evaluating the applicability of new refinery processes which may be related to catalytic cracking, such as delayed coking. An example might be the predicting of catalytic gasoline yields which could be expected in processing coke still gas oil distillates. Comparative yields when burning 5% carbon, approximately equal to 6 wt.-% of the charge stock as coke in a fluid catalytic cracking unit were found to be as follows:

| Catalyst (Plant Aged) | Gravity °API | Yields-% With Catalyst: B | C |
|---|---|---|---|
| **Virgin Feed Stocks** | | | |
| Crude Source #1 | 25.1 | 49.9 | 44.4 |
| Crude Source #2 | 20.5 | 46.7 | 40.4 |
| Crude Source #3 | 21.3 | 45.5 | 41.9 |
| **Coker Stocks** | | | |
| Crude Source #3 | 29.8 | 37.1 | 32.7 |
| Crude Source #3 | 16.2 | | 19.4 |
| Crude Source #4 | 14.1 | | 11.7 |

This comparison indicates that the higher gravity lower boiling gas oil from the delayed coking process, although not as good as a heavier virgin distillate, can be considered a practicable catalytic cracking stock. The heavier gas oils from coking appear to be undesirable feed stocks as they yield too little gasoline per unit of catalyst deposit.

### Process Variables

Examples of the use of the midget pilot plant in the study of process variables could be the determination of the effect of such variables as reactor temperature, the proper use of stripping stream, the percentage of slurry oil recycled, and the regeneration of catalyst to various percentages of residual carbon. Comments on investigations along these lines may be of interest to the readers:

### Effect of Carbon Content of Regenerated Catalyst

Pilot plant work has shown that the amount of residual carbon on certain types of catalyst following regeneration has a profound effect on product distribution. In many cases the productivity of a catalytic cracking operation may be increased appreciably by regenerating to 0.3-0.4% residual carbon as compared to 0.5-1.0%, a normal range in many commercial operations. This may hold, even though the actual amount of coke burned in the regenerator is somewhat less. Higher residual carbon not only makes the catalyst less active, but also less selective. In the pilot plant, raising the carbon on regenerated catalyst from 0.2 to 0.8% by weight was found to produce the following adverse changes in product distribution at 50% conversion:

| Catalyst | 67% "A" (Plant Aged) 33% "B" (Fresh) | 100% "B" (Plant Aged) |
|---|---|---|
| Feed Stock | Crude Source No. 1 | Crude Source No. 2 |
| Gravity °API | 25.1 | 20.5 |
| Products | | |
| Increases Carbon-Wt. % | 1.4 | 1.7 |
| Decreases $C_4$'s-Vol. % | 0 | 1.1 |
| Decreases $C_5$-420° F.-Vol. % | 1.8 | 0.7 |

In the above, at 50% conversion and 0.2% residual carbon on the catalyst, feed stock No. 1 produced 4.3 wt. % carbon and feed stock No. 2, 5.1%. Reactor temperature was 950° F. in all tests.

A similar effect was noted in the refinery commercial catalytic cracking unit. When the regenerated catalyst was controlled to a maximum of 0.4% carbon as compared to about 0.8% previously, the yield of gasoline showed an immediate substantial increase. By raising regenerator temperatures it was possible to maintain substantially the same coke burning rate, so conversion was increased by nearly 3 vol.-%, and a proportionate yield in gasoline fractions resulted. Under the conditions then in effect in the commercial unit the production of gasoline fractions was increased by about 700 bbls. daily from the change in operation.

### Effect of Recycling Slurry Oil

An investigation was made on the effect on product distribution of charging 100% virgin feed stock as compared to the same oil containing 10% of heavy catalytic cycle oil as processed through the slurry settler. Plant aged catalyst "B" was used in the investigation.

Properties of the feed stocks and the slurry oil are shown in Table 3.

Yield data obtained are shown in graphical form in the charts in Figs. 1, 2 and 3. At 50% conversion the percentage of feed stock converted to carbon as catalyst deposit was 1.1 wt.-% higher in cracking the 10% slurry oil blend than the 5.1% produced from the virgin heavy feed alone. Therefore at this conversion level the computed carbon yield from straight decanted slurry oil is about 16 weight per cent, equal to about 19% coke commercially. This indicates the importance of minimizing the recycle of the heavy cracked slurry oil to the reactor.

In conclusion it may be stated that midget catalytic cracking pilot units of the type described are not only practicable, but will assure satisfactory returns on the investment by permitting research that otherwise may not have been undertaken.

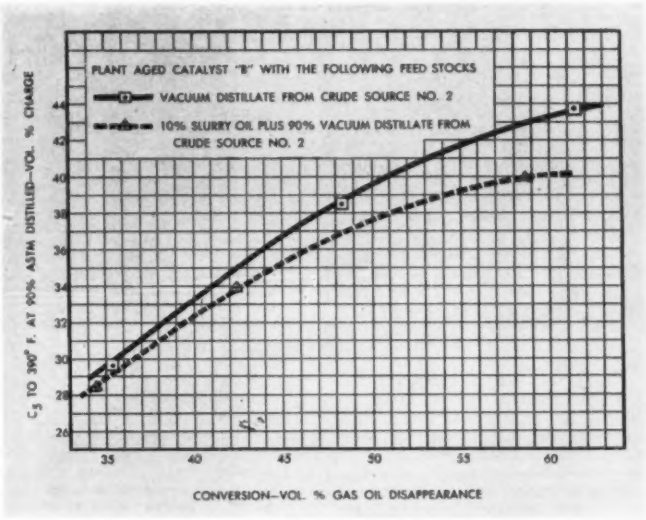

PLANT AGED CATALYST "B" WITH THE FOLLOWING FEED STOCKS
VACUUM DISTILLATE FROM CRUDE SOURCE NO. 2
10% SLURRY OIL PLUS 90% VACUUM DISTILLATE FROM CRUDE SOURCE NO. 2
$C_5$ TO 390° F. AT 90% ASTM DISTILLED—VOL. % CHARGE
CONVERSION—VOL. % GAS OIL DISAPPEARANCE

FIG. 2—Pentanes to 390° F. at 90% dist. vs. conversion


**References**

(1) Miller, W. M., Bisso, L. A., Ayers, W. J., Keever, E. R. Unpublished report of Tide Water Associated Oil Company, Western Division, Research and Development Department (1949).

(2) Grote, H. W. and Hoekstra, J. (Universal Oil Products Company) "Midget Fluid Catalytic Cracking Units Utilize Fluid Catalytic Cracking Technique on Laboratory Scale". General papers presented before the Division of Petroleum Chemistry of the American Chemical Society March 26-30, 1950, Houston, Texas—Page 231.

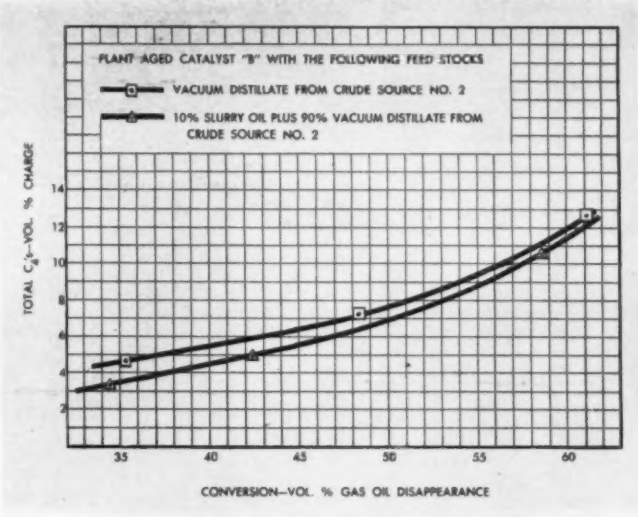


PLANT AGED CATALYST "B" WITH THE FOLLOWING FEED STOCKS
VACUUM DISTILLATE FROM CRUDE SOURCE NO. 2
10% SLURRY OIL PLUS 90% VACUUM DISTILLATE FROM CRUDE SOURCE NO. 2
TOTAL $C_4$'s—VOL. % CHARGE
CONVERSION—VOL. % GAS OIL DISAPPEARANCE

FIG. 3—Total butanes vs. conversion

## REFINERY INSTRUMENTS

# What Makes Them Tick?

### Part 6—Controllers

By **CORNELIUS E. SHANNAHAN**
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THE purpose of a controller is to interpret the measurement it receives so that if the measurement deviates from the control point, the position of the control valve will be corrected to bring the measurement back to the desired control point.

Assume the process variable has now been measured: for example; 1) pressure by means of an elastic element; 2) flow by a differential pressure across a restriction; 3) temperature by balancing a potentiometer or a bridge; and 4) liquid level by a torque tube and displacer. Then the problem is to relate this measurement with respect to a desired value or control point, and to direct a signal to a control valve for any difference that may exist between the two. A controller may respond in a number of ways to a change in measurement. The main purpose of this article will be to analyze the ways in which control is accomplished.

The various means of measurement have just been mentioned. For each method, motion of a pen or an indicator has resulted from following the path of the process variable. It seems reasonable to assume for purposes of this discussion that the type of measurement change is unimportant, and that the controller merely recognizes pen or indicator motion and attempts to keep it at the control point, be it pressure, flow, temperature, or liquid level. In the following illustration, a filled thermal system will be used as the primary measuring element.

Basically, there are five different types of an air-operated controller: 1) on-off, 2) proportional, 3) proportional with reset, 4) proportional with derivative, and 5) proportional with reset and derivative.

Unfortunately, instrument manufacturers have adopted their own trade names for the various functions listed above. To assist in eliminating any confusion because a reader may be more familiar with one particular instrument manufacturer's terms, Table 1 shows a list of the names selected by some of the makers as compared with the accepted terminology of the Instrument Society of America.

Before discussing these types of controllers, a brief review of an instrument "hook-up" will be helpful. Each controller is furnished with an air supply, usually at 17 psig., and preferably clean and dry. The instrument then—depending upon conditions to be described—transmits an output air pressure between 3 and 15 psig. to the diaphragm of the control valve. The stroke of the plug of the control valve in turn is directly proportional to the output air pressure of the controller.

The ultimate effect the pressure change has on the control valve will be covered in the next part in this series of articles. For present purposes it can be stated that depending upon the process, the controller output may increase or decrease with an increase in the measured variable. A good example can be seen by comparing the temperature control of a fluid by heating or cooling. In the event of a temperature rise, it would be desirable to throttle *down* the heat input where the fluid is being heated, and conversely, it would be desirable to *increase* a cooling medium.

**On-off control.** Whereas this type of instrument is rarely used in a refinery, it satisfies approximately 65% of all industrial instrument applications. The capacity-demand ratio determines the suitability of an on-off controller. A process where the demand is small with relationship to the capacity can generally be controlled by intermittent supply. An on-off controller, as illustrated in Fig. 18, operates as follows:

The linkage emanating from the measuring element will rotate the pen arm in the same direction as the measuring element. This motion is also transmitted by linkage to the reversing bell crank, which, depending upon the valve action desired, can be connected to the flapper so that the valve will either open or close for a temperature rise above the control point. This is accomplished merely by connecting the link to the flapper to either of the two sides of the reversing bell crank. If now, for example, the measuring element moves in such a direction as to cover the nozzle with the flapper, air which is being fed to the

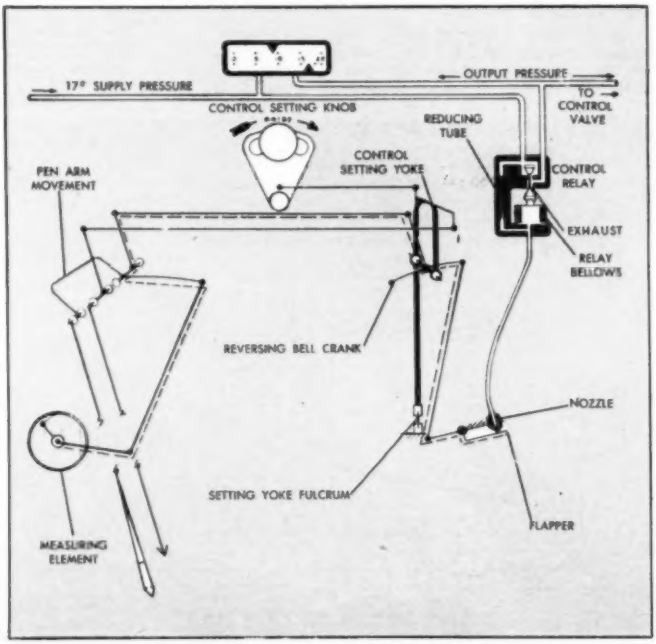


Fig. 18—An "on-off" controller

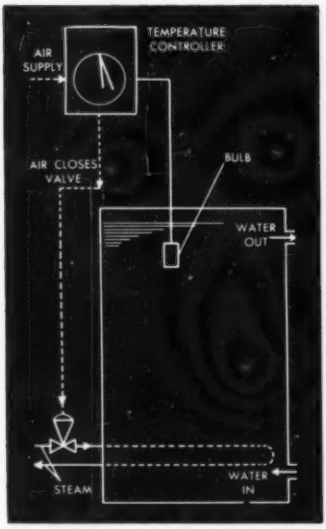


Fig. 49 — Process involving proportional control

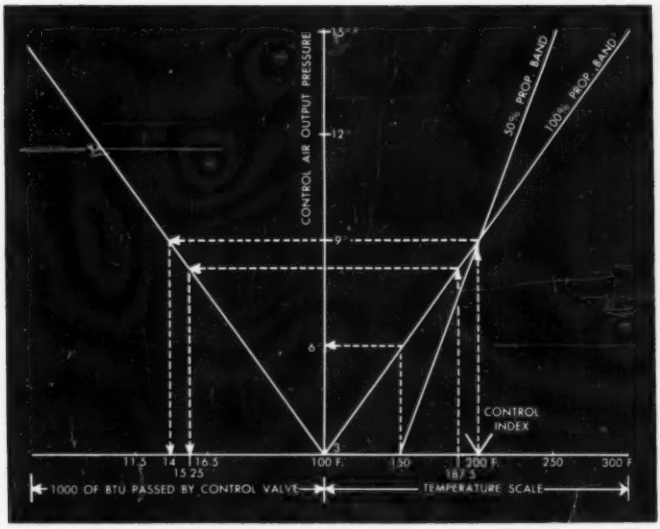


Fig. 50 — Valve position as affected by temperature (see process shown in Fig. 49)

nozzle through the reducing tube of the control relay commences to increase in pressure. (The control relay is sometimes referred to as a pilot.) As the air pressure to the nozzle increases, the relay bellows expands to raise the pilot valve, which closes off the exhaust and admits the full supply air to the control valve. The control valve then strokes from one extreme position to the other.

Conversely, when the flapper uncovers the nozzle, air is exhausted from the control valve, and the stroke is in the opposite direction. The linkages are so arranged that as the pen deviates from the control point—as for example with a temperature change from below to above the control point—the air output will throw the valve from one extreme to the other.

It stands to reason that in any process the control point will be different for various operations. The instrument must therefore be so designed that the control index is adjustable over the range of the instrument. It will be noted that the control index pointer can be set manually, which in effect re-positions the flapper-nozzle relationship so that the on-off action will occur at the desired temperatures on the instrument scale.

**Proportional control.** It is easy to visualize the cyclic effect that would result with an on-off control were there a small capacity-demand ratio. To meet this service, a proportional controller was developed. This type of control means that the amount of valve movement will be proportional to the amount of measurement movement, and valve movement will be in such a direction as to oppose the deviation from the control point. Now, instead of an intermittent action, valve action is continuous as long as there is any change in measurement. Before proceeding with a discussion of the operation of a proportional controller, it will be worthwhile to establish more clearly the principle on which these statements are based.

Suppose for the process illustrated in Fig. 49, it were desirable to maintain a water-out temperature of 200° F. and the index of the instrument has been set at that point. With the process performing satisfactorily, the controller is transmitting 9 psig. Since the position of the valve plug in terms of its stroke is proportional to controller output air, the valve will be half open. (9 − 3 = 6 and 15 − 9 = 6)

Due to a change in process, the water-in temperature drops. As a result, the water-out temperature—and therefore the measuring pen—drops to, say, 150° F. Assuming the temperature scale in the nomograph of Fig. 50 is that of the instrument in the process under discussion, and that the line labeled "100% proportional band" represents the relationship between pen position and control air output pressure (or % valve stroke), it will be seen that the controller will send 6 psig. to the control valve. The valve will then open proportionally to the air pressure change which would admit more steam to the tubes in an attempt to bring the temperature back to 200° F. The temperature scale ranges from 100 to 300° F., and in order for the valve to stroke from fully open to fully closed with a 100% proportional controller, it is necessary for the measurement to traverse completely the instrument scale.

Proportional band can be increased or decreased so that full travel of the valve will result, for example, from a temperature range of 150 to 250° F. This would be a 50% proportional band controller. Proportional band can, therefore, be defined as the % of scale the measurement must pass through in order to effect full travel of the valve.

A proportional controller is illustrated in Fig. 51. The only difference between this and the on-off controller (see Fig. 48) has been the addition of a proportioning bellows and loading spring. Also, the flapper link is connected to the proportioning arc lever instead of directly to the reversing bell crank.

For an increase in temperature, the pen moves clockwise and the flapper moves away from the nozzle. As a result, air begins to bleed from the control valve through the relay valve (pilot). Up to this point there is no difference from the on-off controller action. However, when the pressure begins to drop in the controller output pressure line, the bellows commences to contract upwardly and returns the flapper toward the nozzle.

**Table 1—Control Instrument Terminology**

| U.S.A. | Leeds & Northrup | Taylor | Brown | Foxboro |
|---|---|---|---|---|
| Proportional | Throttling range, or Proportional | Sensitivity | Throttling range | Proportional |
| Reset | Reset | Reset | Reset | Reset |
| Rate | Rate | Pre-Act | Rate | Derivative, or Hyper-Reset |

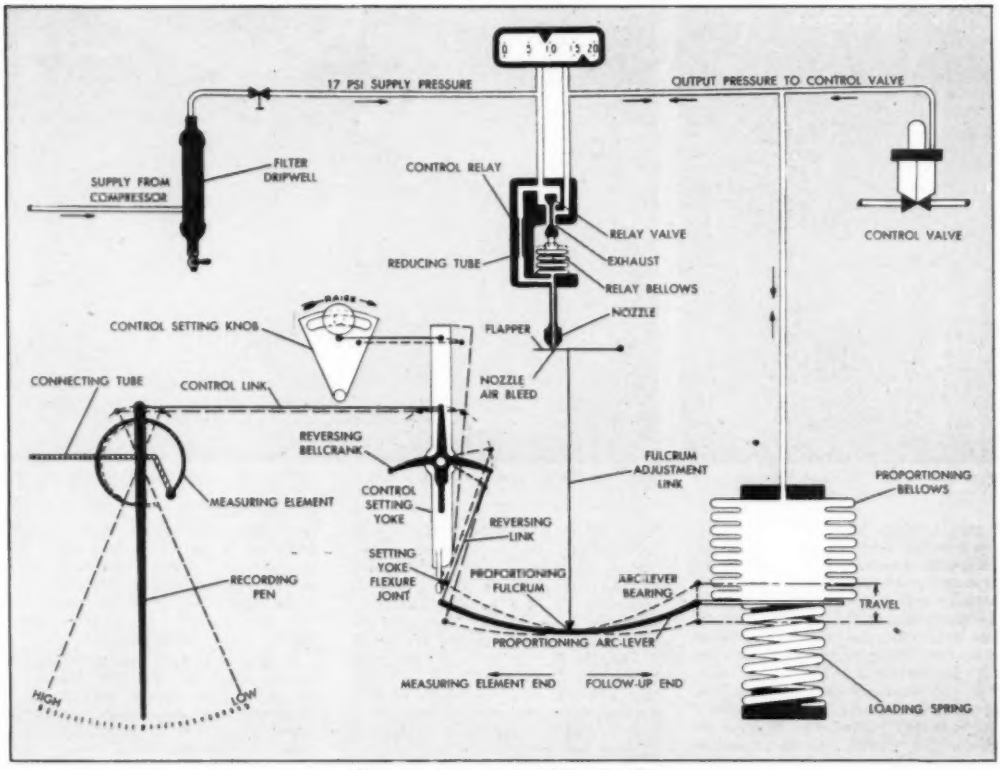


**Fig. 51**—A "proportional" controller

If the pressure drops too much, the flapper will continue to be moved toward the nozzle until the pressure increase and the correct nozzle-flapper clearance is restored. The proportioning bellows might be said to be playing the same role as the feedback system in an electronic circuit.

It might be difficult to comprehend the proportional relationship until it is considered that in order for the flapper to remain in the same position with respect to the nozzle, it will be necessary for the bellows end of the proportioning arc lever to be exactly proportional to the position of the measuring element. And since the position of the bellows is directly proportional to the pressure in the bellows, it is tantamount to saying the output pressure is proportional to the measuring element position. Therefore, the valve position will always bear a fixed relationship to measurement. Or, for every measurement there is one, and only one, valve position. The magnitude of the proportional band can be adjusted by moving the fulcrum adjustment link along the proportioning arc lever. For a given measurement change, a larger movement of the proportioning bellows will be necessary the further the fulcrum is from the proportioning bellows. This, in effect, would be narrowing the proportional band. It is interesting to note that at 0% proportional band we have an on-off controller.

A later model of the same type controller is shown in Fig. 52. The main difference in the two lies in the control relay and the flapper-nozzle connecting linkages. The control relay differs generally in appearance, and instead of a relay bellows there is a metal diaphragm. However, the operating principle is identical. As to the flapper-nozzle mechanism, the striker arm which is attached to the flapper through a shaft rides by means of a hair spring on a pin inserted in the proportioning lever. In order to avoid any misunderstanding of the controller sequence, it might be explained that in the illustration in Fig. 52, the nozzle is not connected to the proportioning lever as it might appear.

The operation of the two types of proportional controllers is identical. But to clarify further any question as to how the mechanism operates, imagine a change in measurement resulting in the proportioning lever moving to the right. As the lever moves to the right, the contact arm follows the pin in the lever and covers the nozzle. The increased pressure in the nozzle system pushes the metal diaphragm down in the control relay and admits air to the proportioning bellows and control valve. The bellows expands and pushes the lever upward to restore the correct nozzle-flapper clearance. The same analysis covering the proportionality of the instrument, as discussed in the preceding paragraph, can then be applied.

The unique feature of this model is the manner in which the proportional band is set. Since a change in measurement results in a horizontal motion of the proportioning lever, it is easily seen that the proportional band can be set by rotating the flapper nozzle assembly as indicated in the dotted circle. In a fairly horizontal position, a large change in measurement would hardly move the flapper, and a wide proportional band would result. While in a fairly vertical position, small changes in measurement are translated immediately to the flapper and, therefore, a narrow proportional band would result. It is al-

so interesting to note the manner in which the air output action of the controller can be reversed. This is accomplished by shifting the contact arm from one side of the horizontal to the other. Above the horizontal, a decrease in output pressure will result from a measurement change moving the proportional lever to the right. If the contact arm is below the horizontal, an increase in output pressure will result from the same measurement change.

The first reaction to proportional control is that here is an instrument to satisfy any process requirement. But this is not true, and following is an example to illustrate its limitation:

Assume a condition for the proportional controller which was setting the water temperature outlet as follows: water quantity, 100 lb./hr.; water-in temperature, 60° F. The number of Btu to raise the temperature is 100 (200-60) = 14,000 Btu/hr.

It can also be assumed that for every valve position, a certain amount of steam, or equivalent Btu's, are admitted as illustrated in the nomograph in Fig. 50. If, for instance, the water inlet temperature drops to 35° F., it follows by simple arithmetic that 16,500 Btu/hr. are required to maintain the water-out temperature at 200° F.

The first limitation of a proportional controller appears in that, in order for the required number of Btu's to be admitted to the process, it is necessary that the pen deviate from its desired temperature. The measuring pen will deviate until the number of Btu's admitted for a given opening will produce the water-out temperature which corresponds to that opening.

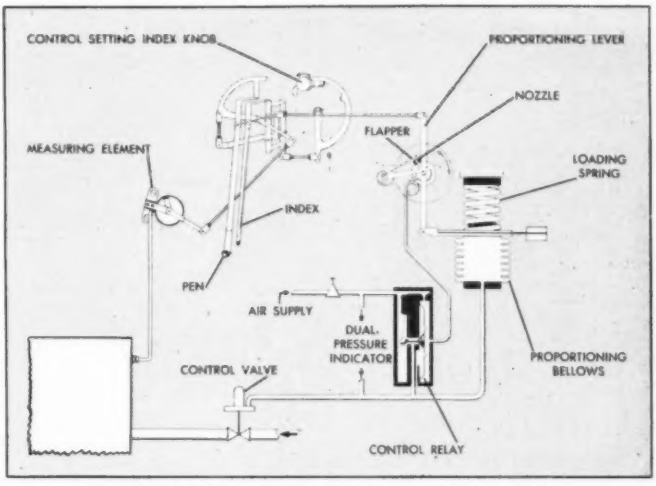


**Fig. 52**—Variation in a later model proportional controller

For the above example, that balance is reached at 187.5° F., which admits 15,250 Btu/hr:

$$\text{Water-out temp.} = 35°\text{F.} + \frac{15250 \text{ Btu/hr.}}{100 \text{ lb./hr.} \times 1 \text{ Btu/lb./°F.}} = 187.5°\text{F.}$$

Because of the importance of understanding the above example, another study may be made where liquid level is to be controlled. Although there are not many occasions in refinery application where it is necessary to maintain level at a definite point, the principles involved are the same. In Fig. 53, the liquid level controller, a variable displacer type, is maintaining liquid level in the bottom of a tower by throttling the air motor-operated control valve in the liquid drawoff line. Assuming the condition as illustrated, the liquid level is being maintained 7 in. above the zero point.

As the level rises or falls, the liquid level controller output air pressure,

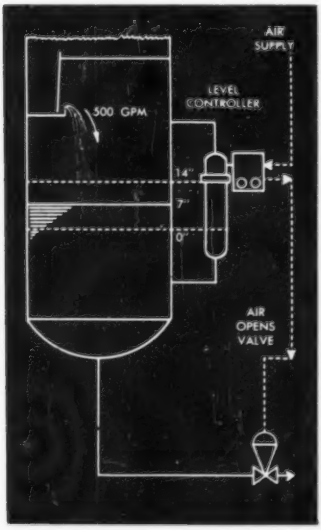


**Fig. 53**—Proportional control of liquid level

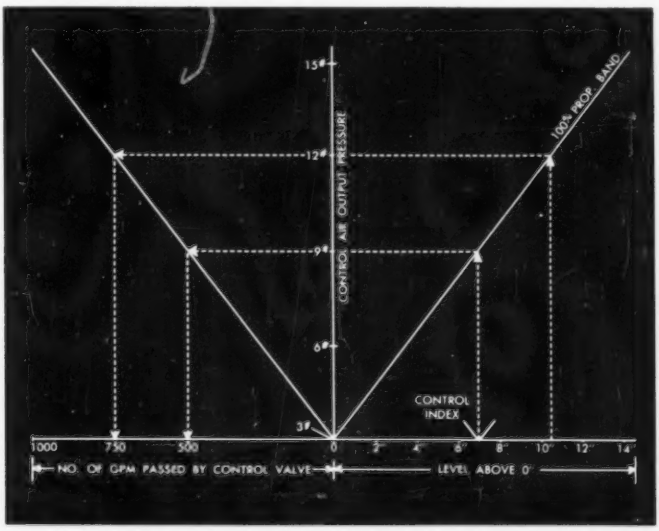


**Fig. 54**—Variations in capacity of control valve shown in the process shown in Fig. 53

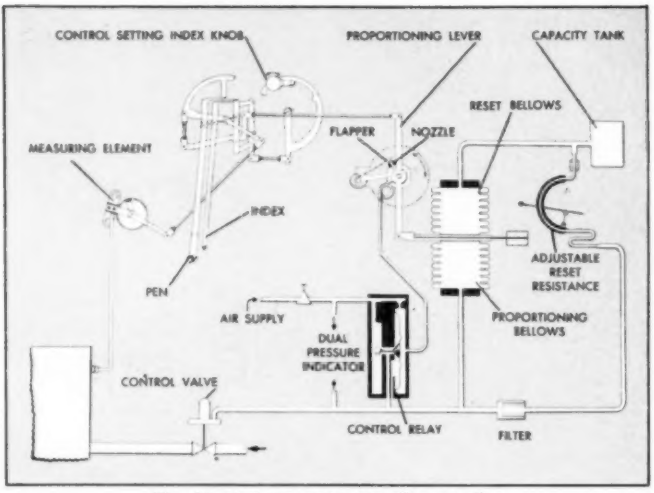


**Fig. 55**—A "reset proportional" controller

and therefore the capacity of the control valve, varies as noted in the nomograph in Fig. 54. If, for example, the overflow rate from the bottom seal pan increases to 750 gpm., the level commences to rise. As in the former example, it becomes evident that for the level to remain in the control range, it is necessary that the level measurement deviate from the desired point. As the level rises, the liquid level controller air output increases until the balance is reached where the capacity the valve will handle is equal to the overflow rate. For the example cited, this point is reached when the level reaches 10.5 in. above zero.

The difference that exists between the resulting and the desired temperature—or level—whichever the case, is referred to as the offset. The smaller the proportional band, the smaller the offset. One immediate reaction might then be to use a small proportional band and thereby reduce the offset. This of course is not always possible, because as the proportional band is decreased the instrument naturally becomes more sensitive, a condition which cannot be tolerated in some process applications. This, then, all relates back to the earlier discussion of capacity-demand ratio. At best the proportioning controller is a stabilizing action, and whether these variations can be tolerated depends entirely upon the process.

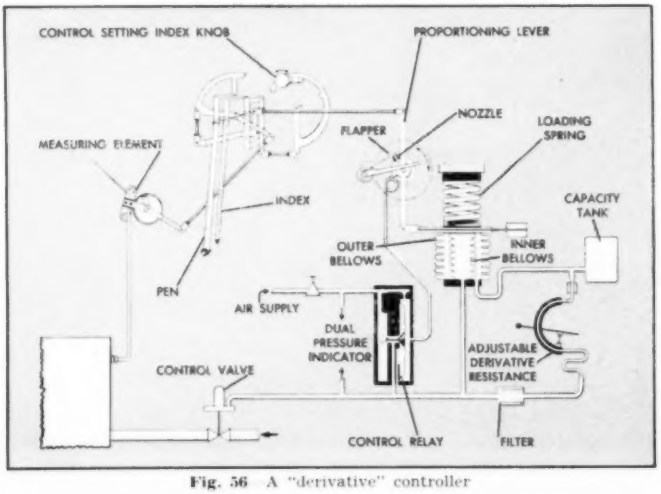


**Fig. 56**—A "derivative" controller

**Reset Control.** It follows that the "reset" feature of the instrument will adjust the position of the valve to maintain the measurement at the control index. Keeping in mind the example just cited, it becomes apparent that there can no longer exist any fixed relationship between measurement and controlled output air for a reset proportional controller.

The reset proportional controller, as illustrated in Fig. 55, differs from the proportional controller only in that the reset bellows, capacity tank, reset resistance, and filter have been added. To investigate further, imagine that the measuring element moves the proportioning lever to the right so that the flapper covers the nozzle. The control relay operates to allow more air to be admitted to the proportioning bellows. As explained previously, the proportioning bellows begins to expand due to the increased pressure to compensate for the change in measurement.

Although the pressure in the reset bellows lags behind that in the proportional bellows, it eventually will be the same, and the time lag will be proportional to the amount of reset resistance. As the compensating movement in the proportional bellows for change in measurement is eventually nullified by the reset bellows, the flapper continues to cover the nozzle. Consequently, the air pressure will continue to increase to the control valve until the measuring element returns to the index point. At that time only will the proportioning lever move back to the left and restore the original flapper-nozzle relationship. Succinctly, the output pressure of a proportional reset control will continue to change until the measuring point is restored to the control point.

In analyzing the control action of a proportional reset controller, it can be said that the proportional correction is governed by magnitude of pen deviation from the control point, whereas reset correction is governed primarily by the duration of the deviation.

It follows that the rate of reset can be varied by adjusting the amount of resistance between the two bellows. Depending upon the process, the resistance can be increased, which lengthens the time for the required pressure to be obtained.

**Derivative Control.** Because of the many lags involved in a control system, and also because of the more exacting requirements on a controller in modern processes, it became necessary in many applications to improve still further on the proportional reset controller.

If it were at all possible, the ultimate in automatic control would be for the controller to "anticipate" an upset or change, and then prepare correctives in the way of valve position. A mechanism, of course, cannot anticipate. But what the deriva-

tive function attempts to do—on the basis of the rate of deviation of measurement from the control point—is to put the control valve in the position it would be if the instrument were able to measure change *immediately*. A derivative controller therefore recognizes the rate of measurement deviation from the control point, and is directly proportional to it. It narrows effectively the proportional band temporarily, and thereby stabilizes the process sooner.

The derivative control has been illustrated in Fig. 56 in conjunction with a proportional controller, for the purposes of this discussion. The only changes that have occurred as compared to a proportional controller have been the addition of the inner bellows, the capacity tank, and the derivative resistance. (The outer bellows and the proportional bellows have the same dimensions.)

To appreciate the derivative effect, imagine again a measurement change moving the proportioning lever to the right and thereby dropping the flapper on the nozzle. As with the proportional controller, the output pressure from the control relay will increase. This pressure increase is felt first by the inner bellows, the degree of which with respect to the outer bellows will vary with the derivative resistance.

Now, comparing the proportional derivative controller with the straight proportional type, it can be seen that for the same rate of deviation from the control point, the output pressure from the derivative type will be momentarily higher. The reason for this is that the inner bellows of the proportional derivative controller is nothing more than a small proportional bellows. Since it has such a smaller area than the conventional proportional bellows of the proportional controller on which to impose its pressure and thus restore correct flapper-nozzle relationship, its output pressure must be correspondingly higher. Considering that the process is leveling off as soon as the pressure begins to increase in the outer bellows, it will relieve the force required by the inner bellows to compensate for measurement deviation to maintain proper flapper-nozzle relationship. And it thereby reduces output air pressure to the control valve. However, the purpose of the derivative feature is accomplished in that it has recognized a rate of deviation from the control point, and has attempted to stroke the control valve to a position where it would be if there were no lag in the instrument cycle. The final position of the valve for either type controller, though, will be the same.

The reason the reset feature has not been mentioned is that in principle it is in no way modified by the derivative effect. It will operate in the same manner as described in the section above on proportional reset. A diagram of the proportional-reset-derivative controller appears in Fig. 57.

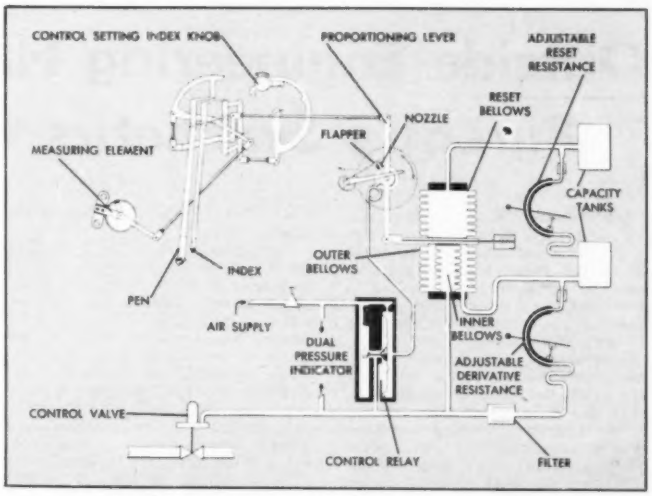


**Fig. 57**—A "proportional-reset-derivative" controller

At this point, it might also be noted that the derivative function would have been possible without the inner bellows. As illustrated in Fig. 58, a derivative resistance has been introduced between the output air pressure line and the outer bellows (proportional bellows). The same characteristics will be attained here as with the unit with an outer and inner bellows. The reason the inner bellows is included is that the instrument would be too sensitive to influences not related to the process, and as a result might create upsets instead of combatting them.

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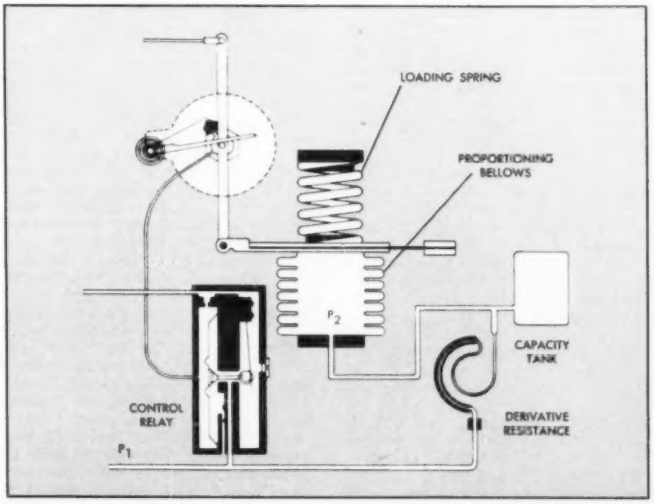



**Fig. 58**—Another proportional-reset-derivative controller, without the inner bellows

# Outside Engineering Firm to Audit Bureau's Synthetics Cost Data

DIFFERENCES in the estimates of the oil industry and of the U. S. Bureau of Mines on the costs for making synthetic liquid fuels by coal hydrogenation have resulted in an independent agency outside the industry being called in to check the Bureau's cost data.

Secretary of the Interior Chapman authorized Ebasco Services, Inc., New York, to make an engineering audit and an independent evaluation of the cost of producing synthetic fuels from commercial size hydrogenation plants. Other phases of the Bureau's work may also be looked into by the Ebasco company. The company had been asked by Chapman to make the study even before the National Petroleum Council issued its report on costs Oct. 31, but the details of the arrangement had not yet been completed.

### Still Pushing Synthetics

It was made plain to the oil industry, however, that the difference in cost estimates of the oil companies and of the Mines Bureau will not halt the plans of the Interior Department to press the issue for commercial synthetic liquid fuels plants now. In an address prepared for Chapman and read before the recent annual meeting of the American Petroleum Institute in Chicago oil men were told:

"I deem it my plain duty as Secretary of the Interior to advance the development of liquid fuels from shale and by synthesis from coal, by any and all feasible, reasonable, sensible means consistent with national laws, national interests and national policy. That may not be your job, but I think that on reflection you will agree it is a job someone must do and that it is, in fact, a part of my job as Secretary of the Interior."

Ebasco Services, Inc., the agency which will make the independent audit, in the effort to reconcile cost differences is a wholly-owned service subsidiary of Electric Bond and Share Co., a large holding company for public steam and diesel electric and hydroelectric power stations in the U.S. and foreign countries, particularly South America. It provides engineering, construction and a wide range of business consulting services to industrial, public utility, transportation, financial and other business enterprises, both small and large, in the U. S. and a number of foreign countries. Its name is formed from the first letters of the name of the parent company.

Its headquarters are in a 26-story office building on Rector St., just off Broadway, in lower New York. Ebasco owns and operates the building, which is its only direct operating interest. Its general office staff of 1500 employes housed in New York includes specialists in the field of accounting, appraisal, budgets, consulting engineering design and construction, finance, insurance, research and others. Ebasco also maintains an office in Washington for technical services for clients in matters arising through the regulations and procedures of government agencies. It also has a branch office in Chicago. Its entire technical staff, however, is housed in New York.

In business since 1911, Ebasco reports over $1,000,000,000 of plant construction from that date, over half done since 1945. This volume of business puts it in the class of the big engineering firms of the country. Its total assets for 1950 were listed as $9,281,598. The company defines its own activities as, "A complete engineering service, from research and planning to ready-to-operate, for business and industry anywhere in the world."

### Has Oil, Gas, Coal Experience

Through its services for some of the companies of the Electric Bond and Share Co. and for outside clients, Ebasco has had some experience in the natural gas and oil industries, in the southwest and in the Rocky Mountain districts particularly. It has also done considerable work in the manufactured gas field and, in the field of utilization of coal, it has improved methods for using pulverized lignite and anthracite as steam fuel, and in air-cooled and water-cooled furnaces for gas, oil and coal fuels.

A recent client of Ebasco has been the Army Ordnance Department, which contracted with the firm to improve the production of synthesis gas used at the Army's ammonia plant at Morgantown, W. Va. The synthesis gas comes from the gasification of coal. The company reports it was commended by high Defense Department officials for this work. While the Ebasco officials have done no previous work for the Bureau of Mines and say they do not know why they were picked for this job, it is quite possible their work at the Morgantown arsenal came to the attention of the Bureau of Mines top officials. The experience of the company both in the oil and gas field and in steam power plants using coal gives it a good background for its new task.

Ebasco has been on this assignment from the Mines Bureau for the study of synthetic liquid fuel costs for two to three months. One of its top men in its industrial engineering division has already visited the Louisiana, Mo., demonstration plant of the Bureau, where a good share of its development work with coal for the manufacture of synthetic fuels is being carried on.

### Bureau Issues Own Cost Report

The difference in costs for making synthetic fuels, as estimated by the oil companies and by the Bureau, was emphasized in the recent presentation of reports on the subject. A special committee from the National Petroleum Council reported Oct. 31 on a study made at the request of Interior Secretary Chapman. "On the basis of operating plants with a total capacity of 216,000 b/d, the cost of producing, but not including the cost of distributing, marketing or sales tax, a gallon of synthetic gasoline from coal hydrogenation would be 43.5 cents per gallon," the NPC report stated. "On the same basis a gallon of gasoline made from oil shale would cost 14.7 cents delivered to a major consuming area. The present wholesale price at the refinery of gasoline produced from crude oil varies from 12 to 13 cents a gallon, excluding tax."

The Bureau of Mines anticipated the NPC report with a report, "Cost Estimate for Coal Hydrogenation" issued Oct. 25. It summarizes the cost of refined liquid product produced by coal hydrogenation, without profit or interest on capital, at 10.75 to 10.9 cents per gallon. Even with profit and interest on capital there remains a wide gap between the cost estimates of the two agencies.

There are some differences in the two sets of estimates for operating costs and for plant investment but these are not great. The NPC committee, after adjusting the Bureau of Mines data on costs from coal issued in 1949, to compensate for inflation of material and labor costs, reported the Bureau's investment cost estimates were approximately 20% below its own cost estimates. In the case of shale oil operations, the

Mines Bureau, having no formal report on which to set up processing costs, agreed to accept the NPC committee's estimate of investment and operating costs.

The main difference in costs is in the items having to do with capital costs, such as interest on borrowed capital, rate of profit required to attract private capital, handling of income taxes, and other capital cost items. There is also great difference in the attitude of the two agencies towards the cost of off-site facilities, such as water supplies, housing for construction and permanent employes, rail and pipeline transportation and others. The differences here are fundamental and reflect the divergence in the views on investment capital in new enterprises held by private industry on the one hand, and on the other by paternalistic bureaucracy which would bolster investment risks by government subsidy.

**Table 1—Summary of Cost Data for Coal Hydrogenation and Oil Shale Synthetic Fuel Plants Developed by the National Petroleum Council's Committee on Synthetic Liquid Fuels Production Costs**

| | Coal Hydrogenation | | Oil Shale | |
|---|---|---|---|---|
| | Single Plant | Eight Plants | Single Plant | Five Plants |
| Coal or Shale: Tons/Calendar Day | 12,960 | 112,590 | 76,800 | 384,000 |
| Products: Barrels (42 Gals)/CD | | | | |
| Gasoline | 19,490 | 163,830 | 25,380 | 126,900 |
| Diesel Fuel | ..... | ..... | 12,200 | 62,360 |
| Liquefied Petroleum Gas | 6,390 | 52,170 | 1,780 | 8,920 |
| Residual Fuel | ..... | ..... | 340 | 3,050 |
| Total Liquid Fuels, B/CD | 25,880 | 216,000 | 39,700 | 201,230 |
| Coke: Tons/CD | ..... | ..... | 1,180 | 5,900 |
| Fuel Gas, 1060 Btu/cu. ft.: Thousand Standard Cubic Feet/CD | ..... | ..... | 24,830 | 124,150 |
| Chemicals: | | | | |
| Phenol, Barrels/CD | 229 | ..... | ..... | ..... |
| Cresols, Barrels/CD | 383 | ..... | ..... | ..... |
| Xylenols, Barrels/CD | 508 | ..... | ..... | ..... |
| Ammonia, Tons/CD | ..... | ..... | 92 | 460 |
| Sulfur, Tons/CD | ..... | ..... | 43 | 215 |
| Manpower: Total including supervision and administration | 5,900 | 53,860 | 3,420 | 15,750 |
| Construction Steel: Thousand Tons | 220 | 1,710 | 178 | 694 |
| Per daily barrel of total liquid fuel production: Tons | 8.5 | 7.9 | 4.5 | 3.5 |
| Construction Labor: Man hours x 1,000 | 51 | 355 | 26 | 123 |
| Investment: | | | | |
| Total, Millions of Dollars | 533 | 4,074 | 333 | 1,518 |
| Dollars per daily barrel product | 20,600 | 18,900 | 8,400 | 7,500 |
| Cost of Gasoline with 6% Return on Investment after Income Tax, Cents per gallon | 41.4 | 43.5 | 16.2 | 14.7 |

### Accountants Checked NPC Figures

As an independent check on its work, the NPC committee retained the services of Price Waterhouse & Co. to review the procedures and basic accounting data used by the committee in determining the estimated operating costs for the two processes. Price Waterhouse necessarily had to accept certain engineering data used in determining the cost figures, but insofar as the estimates used could be tested by the experience of the petroleum industry in refining operations, it was their opinion that the basic accounting data used were computed in accord with generally accepted accounting principles. A summary of the data developed by the NPC committee is given in Table 1 and the following statement on capital costs is contained in the report:

"Although a figure of 6% return on the investment was employed in computing the gasoline cost, it is regarded as highly doubtful if capital could be attracted to so speculative an enterprise at so low a return. Price Waterhouse stated the 'opinion that an annual rate of earnings of not less than 15% on the total capital invested in or retained in a business subject to the risks of a highly competitive and speculative enterprise would be necessary and reasonable in order to attract investment of private capital."

### Bureau Looks for Low-Cost Capital

In a section of its report on "Capital Structure and Profit", the Bureau of Mines states the following to make a case for requiring only a small portion of the investment in a commercial coal hydrogenation plant to be high-cost equity capital, while the major portion would be low-cost borrowed capital.

"In coal hydrogenation, the fact that an absolute, assured supply of raw material, in this case coal, can easily be made available for the entire life of the plant greatly reduces the element of risk. This is quite a contrast to petroleum, where there is great financial hazard associated with crude oil exploration and even in estimating the extent and life of existing oil fields.

### "Process Flexibility Cuts Risk"

"Another factor which reduces the long-term financial risk of coal hydrogenation is the fact that the process is very flexible. For example, either motor gasoline, aviation grade gasoline, diesel oil or jet fuel can be made with only minor changes in plant conditions and equipment. Or, if desired, several principal products as well as various aromatic chemicals can be made simultaneously. This inherent flexibility of the coal hydrogenation process assures that the plant can produce a variety of fuels to meet the demands of future marketing conditions.

"Other factors which remove much of the speculation from coal hydrogenation plants are: (1) the high quality of the products manufactured and (2) the rapidly-expanding market for liquid fuels and basic chemicals. Thus, it is quite certain that there will always be a market for the products and it is equally certain that the plant will be able to make products which will meet future market specifications."

The Mines Bureau sets up a long operating life for even the first commercial synthetic liquid fuels plants, on the basis of a growing market for such products and the fact the first plants will be supplementary to petroleum refineries and in competition with them, rather than with each other. "Future improved synthetic fuels processes, therefore, will not make existing synthetic fuels processes uneconomic overnight or, for that matter, for a number of years," it states.

The risk inherent in the exploration and development of new oil fields is so great that exploration must be encouraged by the promise of high profits and high depletion allowances, the report continues. This is not necessarily true for synthetic fuel plants where the raw material supply is assured from the start, it is stated, although some incentive device may be necessary to attract capital.

The report continues:

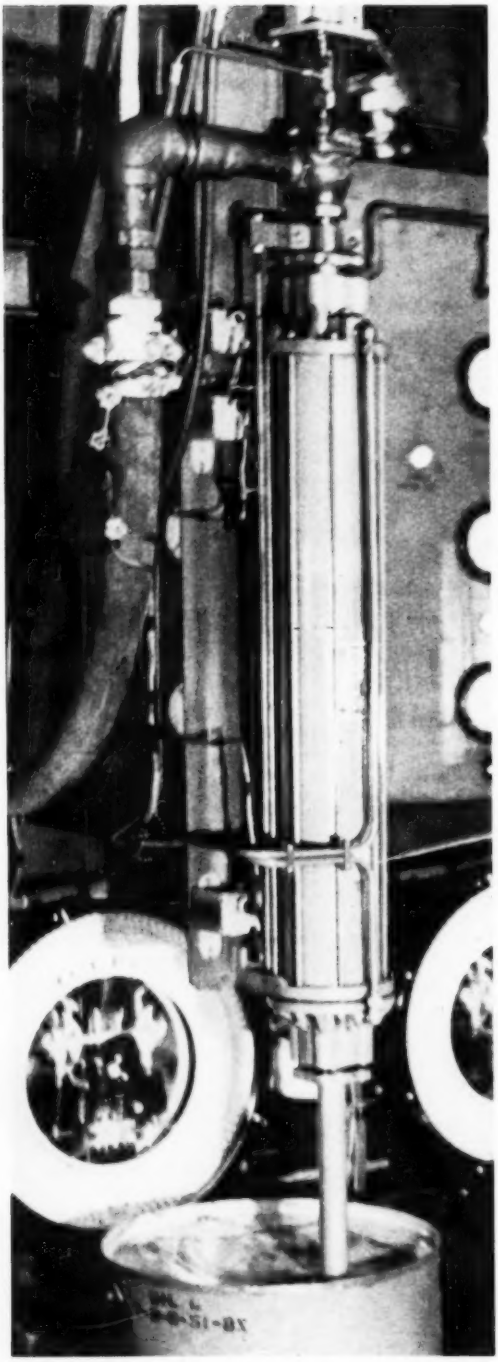
"In contrast to the position of petroleum production, an investment in a synthetic fuel plant, once made, will provide a constant and undiminished source of liquid fuels for periods of 25 years or longer. Obviously, additions and changes will be made to increase capacity, improve operations, and to keep abreast of new developments, but the basic plant will continue on stream with little or no capital investment required to locate new sources of raw materials.

### "60% Borrowed . . . 40% Equity"

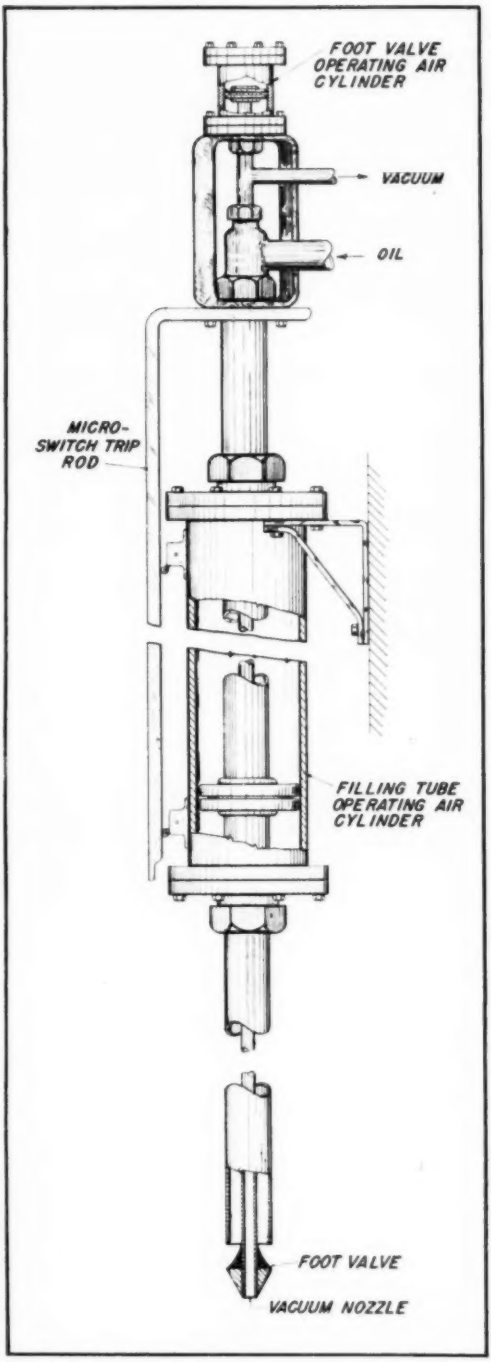
"In view of the relatively low risk on one hand and the stability of synthetic liquid fuel operations on the other hand, the capital structure in this report has been based on 60% borrowed funds and 40% equity capital. Interest on the borrowed money has been taken at 3½%, with interest on the entire capital requirements during the construction period and a financing charge of 0.5% allowed."

### Employe Housing

Of the costs for off-site facilities, the Mines Bureau report discusses only employe housing. Because of the location of coal deposits in many instances in highly populated and highly industrialized areas, unless coal hydrogenation sites are "very poorly located in remote areas, they should not require company-owned towns or housing for construction workers", it is stated.



**FASTER, MORE ACCURATE FILLING** of 55-gal. lube oil drums is achieved with this new sub-surface filler developed by Socony-Vacuum




**SCHEMATIC DIAGRAM** of the apparatus, which uses an air cylinder to raise and lower the filling tube, and a vacuum nozzle to prevent dripping

# Sub-Surface Filling of Drums

## Speeds up packaging, enables one operator to handle as many as 120 55-gal. drums of lube oil an hour

By F. W. LANGNER
and C. R. IRONS
Socony-Vacuum Oil Co., Inc.*

THE filling of lubricating oils into 55-gal. drums has, for a great many years, been recognized and accepted as a slow and primarily manual operation. The two main factors contributing to this situation were the large size of this container and the time required to feed a measured amount of product through the filling nozzle.

Since filling is only one of the several operations comprising a filling line, it is necessary to streamline and coordinate all operations if an overall speed-up is to be realized. Although a minimum of 1¼ min. is required to fill a 55-gal. drum with a standard over-surface type filling nozzle, there was no real need to decrease this time until the allied operations could keep pace with filling.

The development of handling methods was accelerated considerably by the adoption of the roller conveyor which eliminated manual handling to a great extent and caused a general speed-up in filling operations. With these changes the filling process became the bottleneck and new developments were directed toward reducing the time required for this operation.

Early in 1948, during the course of revamping the compounding and packaging facilities at Socony-Vacuum's Paulsboro, New Jersey, refinery, it was recognized that to achieve the desired throughput of lubricating oils, it would be necessary to utilize higher filling pressures from suitable pumps instead of filling from gravity tanks as was the general practice at that time.

After a careful survey of filling requirements, the engineering staff designed and installed four initial filling lines with the primary objective of filling one drum every 45 sec. in each line. All handling facilities were streamlined and mechanized to the fullest extent. Scales with automatic mercury-magnetic shut-off switches and standard oversurface type nozzles were used for filling on a pound basis. Taring of the empty drums in these lines was accomplished manually by a standard chain tare device affixed to the scale. Automatic taring devices were installed at a later date.

Initial efforts to fill at the desired speed indicated that foaming, particularly when filling the lighter grades of lubricating oils, was the chief limitation to rapid filling. Foam build-up was sufficient to limit the capacity of a 55-gal. drum to 54 gal. and, when filling speed was decreased to allow filling 55 gal., drum throughput was reduced by one-third. In order to maintain the high desired throughput, permission was requested to fill drums to 54 gal. until the foaming problem could be eliminated.

Experiments were begun immediately and it was soon determined that all of the air pick-up, which resulted in foaming, occurred at the filling nozzle and apparently bore a definite relationship to the critical velocity of the oil.

Since desired filling speeds could not be attained without exceeding this critical velocity, the most obvious solution was to extend the filling nozzle to the bottom of the drum and fill from below the liquid surface. Experiments were carried out in open head drums to determine the relative effects of over-surface and sub-surface filling.

The results with sub-surface filling were most gratifying. A typical test with a standard over-surface type filling nozzle and a filling pressure of 15 psi., indicated that an S.A.E. No. 10 oil required 83 to 85 sec. filling time. Furthermore, a foam buildup occurred to the extent of 1½ to 2 in. Using a submerged nozzle and the same oil, the filling pressure was increased to 60 psi. and filling time reduced to 43 to 45 sec. In addition, foam was limited to small floating patches, none of which were larger than a 50-cent piece.

On the basis of these tests it was decided to design and install suitable sub-surface fillers in all lines. The requirements of such a device may be listed briefly as follows:

1. The filling tube should automatically and rapidly move to its lowest position with the outlet end just clearing the bottom of the drum.
2. The nozzle outlet design should be such that initial flow of product will keep foaming and kinetic effect of the fluid stream to a minimum.
3. As the liquid level rises, the filling tube should begin to rise just after the outlet end is covered and continue to rise with the liquid level, maintaining a constant submergence, until the capacity of the drum is reached.
4. When flow is stopped the tube should rise rapidly to clear the top of the drum and the dripping of oil onto the drum head must be kept to a minimum.

After many months of development and experimentation, conducted jointly by Paulsboro Engineering and Operating personnel, a filling device was completed which incorporated all of the required features. This subsurface filler, as shown in the schematic diagram, consists of one large and one small air cylinder, a filling tube containing a smaller concentric vacuum tube, a foot valve and several micro-switches operating solenoid valves.

### Details of the Filler

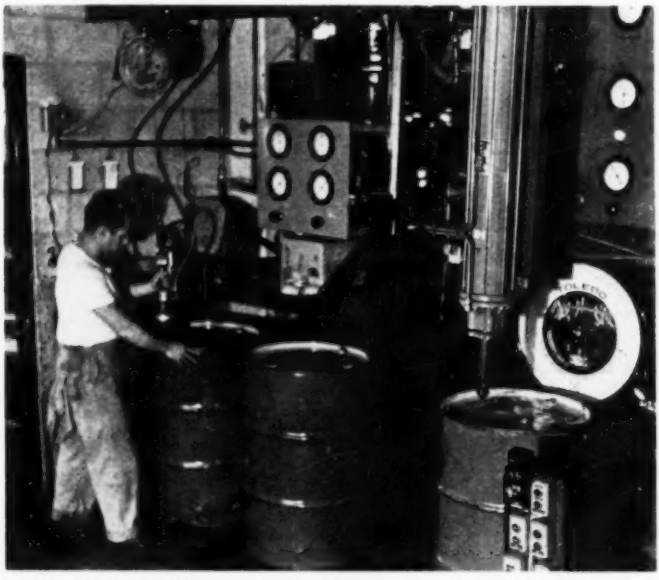
In order to more clearly illustrate the working principle of this filling device, and to avoid unnecessarily complicating its operation, a certain amount of license has been taken with the construction details. Oil and vacuum connections are located on the movable filling tube and compressed air lines, not shown, are connected to the air cylinders. The small air cylinder is mounted on the top of the filling tube and serves only to open and close the foot valve mounted on the lower end of the vacuum tube. The large air cylinder serves to control the movement of the filling tube. Micro-switches mounted on the large air cylinder, are actuated by a trip rod, and, by means of solenoid valves, make the filling operation almost entirely automatic.

The operating cycle is as follows: When the operator has registered the drum opening under the filling nozzle, he starts the cycle with a manual pushbutton which actuates a solenoid valve, admitting air into the top of the large cylinder. The filling tube and small air cylinder move downward and, as the nozzle tip enters the drum, the trip rod contacts the upper micro-switch, releasing the vacuum in the vacuum tube. At the lowermost point of its travel the trip rod actuates the lower micro-switch which opens the foot valve and starts oil flow.

After approximately 60 lbs. of oil is in the drum, the tip of the nozzle is submerged and a magnetic mercury switch on the scale is actuated which, through suitable solenoid operated air valves, starts the slow upward travel of the filling tube. The rate of rise is determined experimentally and depends upon filling pressure. Manually adjusted air valves can be set to control the rise of the filling tube to coincide with the rise of the liquid level.

An additional mercury-magnetic switch on the scale stops the oil flow when the predetermined weight of

* This article was originally presented as a paper at the 13th Annual Forum of the Packaging Institute in New York City, Oct. 24. Mr. Langner is coordinator of packaging activities with Socony-Vacuum, and Mr. Irons is an engineer in the refinery engineering department.



**BUNGS ARE TIGHTENED AND SEALED** on one pair of drums, using pneumatic tools suspended on counter-balanced cables, while a second pair of drums is being filled

product is in the drum. When the foot valve closes, the upward travel of the filling tube is accelerated and, as the nozzle tip clears the drum head, the upper micro-switch is de-energized, restoring vacuums at the nozzle tip and sweeping away the oil draining from the filling tube. The cycle is now ready to repeat.

In actual practice, where high speed filling of a minimum number of grades is required, it has been found feasible to utilize two of these subsurface filling units. These are arranged in series in the filling line and are controlled by one operator. His duties consist of positioning two drums under the twin nozzles, and starting the operating cycle with the pushbutton. While the two drums are filling, the operator inserts and tightens the plugs and installs a metal seal cover on the preceding two drums using pneumatic tools which are suspended within easy reach on counter-balanced cables.

The filling operation was previously described as almost automatic. Since an operator is required to install plugs and seals, automatic registration of the drum under the filling nozzle was considered to be a non-paying refinement which would not only require considerable expensive development but would unnecessarily complicate the entire apparatus. Installing plugs and seals in two drums requires considerably less than 45 sec and, as a result, it is possible for one operator to easily average 100 or more drums per hour. Spot checks have shown actual filling speeds to be as high as 120 drums per hour.

During the past year there have been several requests that this apparatus be made available to other users of filling equipment. In compliance with these requests we have recently completed negotiations with a prominent scale manufacturer who will shortly place on the market a combined filling and weighing unit.

Increased throughput per manhour is only one of the benefits we have obtained through the use of the subsurface filling principle. Perhaps the largest single additional saving is due to the fact that it is now possible to fill 55 gal. into nearly all 55-gal. drums. This represents a saving in container costs at one refinery of over $300 a day. Another large saving results from the increased accuracy of filling which is now within 1 or 2 lbs. in 400 or a variation of no more than ½%.

Referring again to those previously mentioned allied operations, let us follow a drum from its point of receipt at the refinery to its discharge at shipside. Both new and reconditioned drums are received either in truck or carload lots and unloaded manually, in an upright position, directly onto a live roller conveyor. The first station in the conveyor line is located at the entrance to the filling room. Here the drums are inspected and the ¾-in. bungs and seals applied. For a certain few export shipments, where gross weight marking is required, the tare weight is also chalked on the drum head.

Leaving the inspection station the drums are routed to the proper filling line, where they pass through the stencilling booths to apply corporate signature, brand name and grade, gross and net weights and other similar information. Spray paint guns and brass stencils are used in this operation.

The drums, now moving by gravity, approach the filling station where a short section of powered rolls keep a steady supply of drums within reach of the filler operator. In order that these rolls do not rotate continuously, a photocell device is actuated when the filler operator moves two drums onto the scale rolls. The use of scales, equipped with automatic taring device, not only provides extremely accurate filling but also eliminates the need for tare and check weighing.

After the bungs are sealed the drums move along the conveyor to a diverting switch, where they are arranged in groups of four on parallel conveyors. Here the drums are picked up by fork-trucks equipped with Traynor-Reinhart 4-drum carriers and deposited on trailer trains for transportation to the dock or to the storage warehouse. At the dock they are again handled by the carrier-equipped forktrucks and are either stacked for temporary storage or carried directly to the downender, where they are knocked down.

In all of the foregoing operations, manual labor is kept to a minimum by the fullest possible usage of mechanical equipment. Careful planning has resulted in a coordinated operation that assures a continuous flow of accurately filled drums while utilizing a minimum of manpower.

## This Equipment Will Be Available

The apparatus described in this article will soon be available to other users of filling equipment. Socony-Vacuum Oil Co. has recently completed negotiations with Toledo Scale Co., which will shortly place on the market a combined filling and weighing unit. The company told PETROLEUM PROCESSING that it is now developing the commercial apparatus, and expects to be ready to take orders for it about the middle of 1952. Delivery, as usual, will be dependent upon the availability of materials.

## *Protecting Refinery Pressure Equipment from*

# Graphitization

**By D. B. ROSSHEIM, J. J. MURPHY, R. H. CAUGHEY and W. B. HOYT, M. W. Kellogg Co., New York***

PRACTICAL suggestions for protecting existing refinery pressure equipment operating at high temperatures from the effect of graphitization of the carbon steel have resulted from recent studies of metal deterioration in some catalytic cracking equipment. Suggestions have also resulted for the selection of steels for new construction or replacement which are resistant to this condition.

The studies reported have been carried on by the M. W. Kellogg Co., refinery engineers, and are based on their investigations this year of three integral-clad catalytic reactors, where the welded seams were found to have developed cracks after about 7 years in service. Other reactors, both of the clad and unclad type, in similar service were also examined. The company also has a background of experience in this subject from its work of a few years ago in conducting extensive tests for graphitization of piping and other equipment in power plants.

The damaging effects of graphite in refinery equipment to the degree experienced in the power industry are not obvious at this time, the Kellogg report states in a summary of the findings. In fact, graphitization does not appear to be solely responsible for the cracks in the three integral-clad reactors examined. In view of the relative early obsolescence of refinery equipment, certain amounts of graphite can be tolerated it is stated. Service examinations should be made of susceptible materials to develop the possible progress of graphitization, which is defined briefly as the formation of graphite, a form of carbon, by the decomposition of the iron carbide in the steel. The graphite appears in different forms.

As has been reported earlier,[1] a graphitization subcommittee of the API Committee on Refinery Equipment has initiated a program of sampling and examining high temperature equipment of all kinds in refineries, in an effort to accumulate experience on the tendency of carbon and low alloy steels to develop graphite. Its work has not yet reached the point where results can be reported.

Both the Kellogg company and the API studies resulted from the discovery on Feb. 8, 1951, of a leak in the reactor of a Fluid catalytic cracking unit after 53,000 hours of operation at 900°-975° F. The reactor was of the integral-clad type, the base metal being carbon steel (ASTM A-201 Gr. A) and the cladding 18% Cr-8% Ni-Cb (Type 347). Examination disclosed a crack adjacent to and paralleling a longitudinal weld, and further examination disclosed numerous cracks of a similar type in the carbon steel at welds throughout the vessel, as well as cracks in the inside alloy weld deposits. Examination of samples cut from the vessel revealed the carbon steel base metal to be graphitized, the graphite being nodular in form and in general uniformly distributed.

There are in refineries seven other clad reactors of essentially the same construction and with similar service and operating time. In two of these, numerous cracks were found similar to those in the first reactor examined; specimens from one had relatively small amounts of graphite while those from the other contained substantially no graphite. Two others were reported free from cracks, although samples from the base metal of one contained heavy nodular graphite. Visual examination of another reactor disclosed a crack adjacent to the weld joining the top cone to the overhead line.

To date, sampling and examination by the Kellogg company has also included other carbon steel reactors in similar service, some without alloy linings and some with 18% Cr-8% Ni or 11-13% Cr alloy steel spot-welded liners. Pipe operating above 900° F. has also been sampled. No cracks have been found; although some samples contain nodular graphite in varying degrees of concentration, most are not graphitized.

The studies by the Kellogg company covered several topics concerned with the graphitization of carbon steel and its effect on the service life of refinery equipment. Other causes of cracking in the walls of reactors were explored, including a theoretical study of stresses and plastic strains in integral-clad pressure vessels. The effect of graphite on the mechanical properties of carbon and carbon-molybdenum steels as a possible cause of their deterioration was another topic; welding on graphitized steel another. Also, as referred to above, suggestions were presented for protecting existing equipment from the effects of graphitization and for the selection of steels and other materials for construction and maintenance which would make the equipment more resistant to graphitization.

Because of the practical aspects to refiners of this last named section of the report, it is published below in full. Other sections are reviewed in a later part of this article.

## *Precautions for Present Equipment, Suggestions for New Construction*

### Existing Equipment

For carbon or carbon moly steel in service above 850° and 900° F. respectively, the following precautions should be considered:

1. All equipment operating at temperatures where there is continuous plastic flow with time should be periodically inspected for the possibility of cracking at welded seams and locations of stress concentration.

The frequency and extent of inspection should be based on the severity of the operating conditions; temperature, pressure, thermal or mechanical shock, fatigue effects, etc. Visual inspection should be supplemented by magnetic particle examination as far as practical and any doubtful area should be ground to facilitate examination.

Such inspection practice can be expected to give reasonable warning of any unsafe condition, whether due to graphite or other cause. If any cracking should be discovered, the examination should be extended and intensified, grinding where necessary and using magnetic particle examination, and samples should be taken as in (2) below.

2. For equipment in service over 30,000 hrs., or where cracks have been located by visual or magnetic powder inspection, weld-prober or plug samples for micro examination are desirable. Where pressure equipment is operating well above the minimum temperature at which graphite might form, sampling at an earlier period would be advisable, say 10,000 hours

* From a report presented before the annual meeting of the American Society of Mechanical Engineers, Atlantic City, Nov. 25-30.

* D. B. Rossheim is Staff Engineer of M. W. Kellogg Co.; J. J. Murphy is Mechanical Development Engineer; R. H. Caughey is Asst. Chief Metallurgist, and W. B. Hoyt is Materials Engineer. The official title of their report as presented at the annual meeting of the ASME in Atlantic City was "Recent Experience in the Examination of High Temperature Catalytic Cracking Pressure Equipment."

for carbon steel operating at 1000° F. or more.

Specimens should contain base metal, heat-affected zone and weld metal; weld-prober samples across welds are preferred since they permit miniature side bend tests of the heat-affected zone as a check on ductility. The need for and frequency of subsequent sampling will depend on the condition of the initial samples.

The limitations of sampling as an accurate index of the status of graphitization in a given piece of equipment should be appreciated. The susceptibility of steel to graphitization has been known to vary from heat to heat and even over adjacent areas of a single plate or pipe, so that freedom from graphite in samples will not give positive assurance of the complete absence of graphite or that concentrations of graphite may not be present. Sampling, nevertheless, is the most valuable available tool and the reliance to be placed on information obtained is proportionate to the variables present and the degree to which the selection, location and number of the samples represent them.

3. Where cracks, significant loss in ductility, heavy concentrations of nodular graphite, or chain graphite are present, additional specimens are desirable to assess their extent. Decision must be reached as to the feasibility of repairs, and safety in continued operation subject to frequent check inspection and sampling, or whether replacement is desirable.

4. As a means of prolonging the life of impaired vessels or large piping or arresting the progress of graphitization at any stage, internal insulation can be considered where the service permits such construction. Insulating concrete linings are discussed under new construction.

5. Where welded joints involving materials with dissimilar coefficients of expansion operate at elevated temperatures, particularly in cyclic service, care should be taken to subject them to periodic inspection for cracks. The frequency of inspection should depend on the magnitude and frequency of the cyclic service as well as on the degree of difference between their coefficients of expansion.

## New Equipment

For projected construction or replacement of pressure equipment the following suggestions are offered in the light of present knowledge of graphitization.

**PIPING:** The choice of piping materials for service over 850° F. involves considerations of material strength, resistance to oxidation and corrosion, availability, ease of fabrication and possible alterations or repair, as well as stability against graphitization.

Where operating pressures are low and the possibility of severe mechanical shock or vibration effects are remote, carbon steel would seem to be a justifiable choice. The use of carbon steel would be particularly appropriate for use in lines which normally operate at temperatures below 850° F. but which are designed for higher temperatures because of occasional operation for periods of limited duration at temperatures over 850° F. Although carbon steel with unspecified deoxidation practice may be used, it would be desirable to obtain, where possible, steel which is melted with controlled deoxidation practice as indicated in the Specification Requirements given below.

For service considered to be more critical as a result of high pressures, shock or fatigue effects, possible overloads, inaccessibility, etc. the use of an alloy steel is justified. Except for improved high temperature strength, carbon-molybdenum steel offers little advantage over carbon steel and in view of the unsatisfactory experience in the power industry, its use is not recommended. The 1% Cr—½% Mo or the 1¼% Cr—½% Mo steel provides good elevated temperature strength and immunity to graphitization to at least 1050° F.

For large diameter piping, above 30 in. diameter, the suggestions given below for pressure vessels may be applied.

**PRESSURE VESSELS:** Three alternates may be examined. For individual applications the choice will depend on the influence of vessel size, desired life, pressure, temperature, degree of cyclic or shock loading, service, necessity for field erection and alterations, maintenance, and relative economics.

**(a). Killed Carbon Steel:** For metal temperatures over 850° F. carbon steel, if used, should preferably be low aluminum deoxidized as specified below. Its use should be on the basis of providing adequate inspection and metallurgical examination in service.

For temperatures over 900 F., design provisions should be incorporated in the inside dimensions, supporting steel and foundations for a possible future internal insulation. Should significant graphite be discovered the internal lining could be economically and readily installed to arrest its progress at any stage desired. As indicated previously, graphite in base metal would be of little concern but on any indication of a tendency to form and build up concentrations in the weld heat-affected zones the lining should be installed.

**(b). Carbon Steel with Internal Insulation:** By providing internal insulation initially the shell metal temperature can be maintained below 800 F. with internal flow temperatures well above this. The type of steel used and the deoxidation practice is not important from considerations of graphitization unless overheating occurs due to loss or ineffectiveness of insulation. This should be guarded against by special attention to insulation choice and details and by providing a reasonable margin between expected metal temperature and actual design metal temperature.

With design metal temperature of 650 F., which permits full use of the material strength, the metal weight saving will often offset the cost of the liner, and for higher flow temperatures (over 900 F.) and larger size vessels, the relative cost is in favor of internally insulated construction.

**(c). Graphitization Resistant Steel:** It is indicated that ½% Cr—½% Mo and 1% Cr—½% Mo steels are resistant to graphitization up to 950 F. and 1050 F., respectively, and are presently the most economic choice of resistant materials. Both are slightly air hardening, the former comparable to carbon moly steel, and are commonly considered to require preheat to 400 F. and thermal stress relief.

Tests and fabrication experience in the M. W. Kellogg Jersey City plant indicate that underbead cracking is effectively eliminated by the use of low hydrogen electrodes so that welds in low carbon (about 0.08% C) 1% Cr-½% Mo steel can be made safely with preheat reduced to 200 F., with no postheat necessary to reduce hardness or obtain desired ductility.

These easements are not very significant on shop constructed pressure vessels where the higher preheat and stress relief can be provided without great difficulty, and are still advised. However, for field fabrication involving position welding and limited experience of local welders with low hydrogen electrodes, a simple procedure which is not too sensitive to variations in preheat and post heat is practically essential. Even so, unsuspected difficulties and excessive repairs might be encountered on initial field installations which might compromise fabrication economics and safe construction. An example is the unexpected root cracking cited by A. H. Goodger[2] in trying to use low hydrogen electrodes in welding 1% Cr-½% Mo pipe.

As yet, no known installations of 1% Cr-½% Mo steel pressure vessels have been field fabricated; however, it is understood that one vessel is scheduled for construction with carbon content probably around 0.12%. It remains to determine whether this carbon content will be found practical under field conditions. With either shop or field fabrication, radiographic examination would be considered essential and stress relief desirable even though limited to 900 F. A serious drawback under present conditions is the procurement problem since ingots are not avail-

able and amounts less than full heats are subject to parallel orders for scheduling, which can cause serious delay and expense.

**SPECIFICATION REQUIREMENTS:** For high temperature service (over 850 F.) all carbon steel material (plate, forgings, castings, tubing, pipe, shapes, etc.) should be produced from steel melted in accordance with a deoxidation practice restricted to the use of $\frac{1}{2}$ lb. of aluminum per ton maximum. Further, the material should have a coarse grain size and be free of abnormality on McQuaid-Ehn carburization test.

**INSULATION LINERS:** Internal insulation has been extensively employed over many years in high temperature equipment. With adequate design, materials, fabrication and inspection, linings have been satisfactory. Large diameter Fluid catalyst regenerators lined with panels of gunite-applied insulating concrete with a surface of refractory concrete reinforced with steel grating and supported at frequent intervals to the vessel shell by welding studs have given maintenance-free service for over 5 years. Similar linings have been used and are being specified for reactors of Fluid catalyst cracking units.

Insulating concrete linings with aggregate selected for structural strength and without surface reinforcement have been used in regenerators; they involve lower first cost, but are more likely to involve extensive maintenance. In reactor service the insulation will be infiltrated by coke which will raise its thermal conductivity, requiring proper allowance in design; this may cause cracking or spalling unless the surface is suitably retained. It is highly desirable to omit external insulation, thus exposing the exterior to observation for evidence of overheating or deterioration. Vessels having both inside and outside insulation are much more sensitive to overheating due to deterioration or ineffectiveness of the internal insulation.

Internal insulation may lower the inside steel shell temperature below the dew point of the flowing medium; also, condensate may be retained during shutdowns unless lengthy drying out with non-condensible vapor is exercised. While ganister concrete linings have been reasonably effective against corrosion in thermal cracking, such installations were provided with external insulation and the dense concrete, aided by coke, probably sealed off the shell surface. It is possible that cement wash from the insulating concrete will serve as reasonable protection; on the other hand, porous aggregate may penetrate to the metal, providing paths for liquid flow. It may be advisable to protect the metal shell against condensation by a thin first coat of dense concrete, a cement wash, two coats of acid resistant high temperature paint, or a silicate of soda wash, etc.

**DISSIMILAR METAL WELDMENTS:** For elevated temperature cyclic service it is advisable to avoid wherever possible the use of welded joints involving austenitic and ferritic steels. This is not always possible since many times carbon steel vessels must be provided with stainless liners for corrosion resistance. Where lined vessels with composite welds operate in cyclic service, provision should be made for periodic inspection of all main seams.

# Causes of Cracking, Including Stress in Bimetallic Construction

*Below is a brief summary of Sect. III of the report, "Exploration of Causes of Cracking," and III-B, "Theoretical Study of Stresses and Plastic Strains in Integral-Clad Pressure Vessels."*

Occurrence of cracks along the edge of welds in high temperature pressure vessels is a more general problem than is indicated by the specific cases reported. In the past, when such cracks have occurred, the problem of why the affected area should be inherently weak usually received only the limited attention necessary to its repair or replacement. Vessels in cyclic service, such as hydroformer reactors or coke drums, which are subject to repeated changes of temperature, are susceptible to cracking at weld edges.

Of the various factors considered for their possible influence on the initiation or propagation of cracks at the edge of welds in the three integral-clad reactors, the following were found to be of negligible or minor influence:

Underbead cracks; stress concentration due to undercutting at the edge of welds or heavy weld reinforcement; hydrogen embrittlement due to the use of electrodes not of the "low hydrogen" variety; fatigue in cyclic service; impact and vibration effects from the incoming catalyst stream on the Fluid catalyst bed; notch effect at edge of alloy weld deposit due to its greater depth than the alloy cladding thickness; propagation of initial fabrication cracks in alloy or carbon steel welds, such as micro-cracks or cracks at the junction between the carbon and alloy steel.

Regarding the effects of graphitization on mechanical properties of the steel in the three reactors examined, the report states:

"There is no positive connection between the graphitization and the development of cracks. In the reactor in Unit A which showed appreciable nodular graphite, the cracks primarily followed the heat-affected zones where there was a tendency for graphite concentrations. The segregated graphite observed in heat-affected zones, however, was not of the "eyebrow" type found on the Springdale power plant failure, but was nodular and might be more descriptively termed "bead" type. Bend tests have shown that moderate amounts of "bead" type graphite do not adversely affect ductility, although a few tests of welded joints with particularly heavy concentrations have shown reduced ductility in a degree proportionate to the amount of graphite present.

"Little is known about the possible effect of such segregation on the long time high temperature strength and ductility, or the fatigue or shock resistance of welded joints. While segregated graphite appears to have been an influence in the development of cracks in the case of Unit A, this is not supported by the findings on Units B and C, the former having little graphite and Unit C being practically free of graphite.

"The degree of spheroidization also varied. The steel for all three vessels was supplied from the same source at the same time; in fact, some heats are represented by plates in more than one vessel. The difference in degree of deterioration is not readily explained, but the difference is sufficiently marked that graphite cannot be explained as a primary influence in causing the cracking".

Three factors related to thermal stress in bimetallic construction were examined in detail as possible causes for the cracks which appeared in the reactors of the catalytic cracking units. These factors were (1) thermal stress resulting from difference in expansion of alloy and carbon steel in integral-clad plate or composite welds; (2) fatigue attendant to thermal cycling in integral-clad plate construction; (3) stress-rupture failure due to combined operating stresses.

To aid in the study of behavior of clad vessels in high temperature service, formulae were developed for the elastic thermal stresses for the general case of a thin integral-clad plate cylinder. There were also developed formulae for the local bending and hoop stresses at a welded joint; for

the relaxation of thermal stress with time at temperature in the presence of pressure stress; and, finally, for the subsequent division, under steady stated creep conditions, of the internal pressure load between the alloy cladding and the carbon steel backing. The local stresses at welds result from the difference in thickness, composition and attendant differential expansion of the alloy portion of the weld, and the formulae derived for them, together with the equations for relaxation, permitted exploration of their possible influence on the cracks.

In discussing this phase of the study of the causes of cracking in the three catalytic cracking unit reactors the report stated:

"It is the opinion of the authors that thermal strains and strain gradients at welds were not sufficiently severe to initiate cracks in sound material of the expected physical properties. However, cyclic thermal strains could initiate cracks in zones of low ductility or fatigue resistance, or propagate existing flaws or cracks. The prevalence of cracks adjacent to welds points to some weakness which is inherent or which developed in the structure of this zone. The extent of cracking at girth welds, which was at least as extensive as at longitudinal welds, would appear to be an indication that thermal rather than pressure effects were responsible for disclosing weak zones.

"It is known that some difficulty was encountered with micro-cracking of the alloy weld deposits during the vessel fabrication and that the original welds contained some such defects. These may have contributed to stress concentrations at the weld areas. Another factor which would add to the local stress effects at welds is the variation in the cladding thickness encountered on these plates, which varied up to 40% of the total thickness and might be different on either side of the weld. The Unit B reactor was cracked practically as badly as the Unit A reactor, even though it had only 11 cycles as compared to 26 for the latter vessel, while the Unit D reactor of the same design and operating time is still intact after having gone through 20 cycles; other units are not in difficulty as far as is known. Experience, therefore, does not permit any firm conclusions to be drawn".

The Kellogg company's study of the thermal effects in integral-clad plates included, in addition to the 18% Cr-8%Ni cladding, changing the cladding to 11-13% Cr steel, since vessels of this type are in similar service in refineries. The same vessel dimensions and operating conditions were assumed. No difficulty has thus far been reported with vessels with the 11-13% Cr cladding, it is reported.

**WELDING:** In connection with the repair of reactor shells, the questions were raised as to what effect welding would have on graphite particles in the intially unaffected base metal, and the associated effects on the mechanical behavior of a repair weld joint. Results are given in the report of some limited test welds made in heavily graphitized carbon steel. The problem of welding on graphitized steel, it is brought out, is under consideration by a sub-group of the ASME-ASTM Joint Research Committee. General comment on welding in the Kellogg report is:

"The discovery that graphite in the plate materials was associated with the cracks in the Unit A reactor posed the problem as to whether or not suitable and serviceable weld repairs could be made. Favorable precedent established in the power industry notwithstanding, noticeable differences in the form and distribution of the graphite observed in refinery equipment materials suggested that preliminary weldability tests were probably warranted.

"In samples removed from the Unit A reactor graphite was found concentrated in the heat affected zones of weld joints, which was unlike the power piping experience. However, it was observed that graphite was also present in the unaffected base metal, in certain cases in copious quantities. This condition in the experience of the authors with power piping equipment has been the exception rather than the rule. Repair of graphitized weld joints in steam piping has usually involved the complete removal of a weld joint including the graphitized heat-affected zones. The new welds were then made on material substantially free from graphite and it has been found that this procedure has insured the elimination of graphite effects for limited service at least. Comparable procedures are not practicable in the repair of a reactor shell."

**Acknowledgments**

Grateful acknowledgment is given to the companies who made available the samples and data on which the report is based; also to the Timken Roller Bearing Co. and General Electric Co., who helped by making the aluminum and alumina determinations.

Special credit is given to Howard Richards of the Metallurgical Laboratory of the M. W. Kellogg Co., who prepared the microphotographs and performed most of the mechanical tests reported. Credit is also given to H. S. Blumberg, Chief Metallurgist of the Kellogg Co., for his advice and helpful criticism.

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(1) "Effect of Temperature on Carbon Steel in Refinery Service Being Surveyed," PETROLEUM PROCESSING, July, 1951, p. 719.
(2) "Heat Treatment of Pipeline Welds," *Engineering*, July 27, 1951.

GIGANTIC OIL REFINERY
"FIRST DROP" CEREMONIES FOR THE NEW GIGANTIC OIL REFINERY
FORTH
"I HATE TO SAY THIS BENTLY BUT IT'S STILL CRUDE OIL!"

# Thermal Cracking

## Effects of process variables and feedstock properties on the yields and compositions of the products

At severe cracking conditions and sufficiently long residence times, it appears that the distribution of gaseous products of hydrocarbon pyrolysis is relatively independent of the molecular weight and structure of the feedstock. The only charge hydrocarbon property exerting any significant influence is the ultimate analysis, expressed in terms of the carbon-hydrogen weight ratio.

Data and correlations are presented from laboratory cracking tests of petroleum oils at pressures of 1 to 4 atm. abs. and temperatures from 1400 to 1700° F. Oils ranged from Bunker C fuels to natural gasolines. Residence times ranged from 1 to 14 secs. in atmospheres containing varying concentrations of hydrogen, methane, ethylene, and inerts. Empirical equations are presented for estimating gaseous product distribution in inert or hydrogen-containing atmospheres as a function of the C/H ratio of the feed, residence time, partial pressure of oil gas, cracking temperature, and hydrogen to oil feed ratio.

By H. R. LINDEN*

IN STUDIES of product distribution resulting from thermal cracking operations, the emphasis has generally been placed on the liquid products and the higher molecular weight gaseous hydrocarbons[11]. Only a limited amount of work has been done to correlate operating conditions and oil properties with the composition of the gaseous products for the conditions employed in gas manufacture. At the severe cracking conditions used in gas manufacture the gaseous products consist primarily of methane, ethylene and hydrogen. The volume concentration of higher paraffins, olefins, diolefins and aromatics is relatively small.

Expansion of natural gas distribution facilities has made necessary increasing use of various oil gasification processes[6, 12] for the production of approximately 1000 Btu/cu. ft. gas for meeting peak load demands and as stand-by. This trend has been intensified by conversions from the standard 530-540 Btu/cu. ft. gas to higher Btu gases to increase the thermal capacity of existing distribution systems.

While it has been relatively easy to produce oil gases from a variety of petroleum oils, these gases have varied in interchangeability with the natural gas or mixed gases distributed. A greater knowledge of the factors causing variations in the quantities of the paraffins, unsaturates and hydrogen in the oil gas has therefore become necessary to permit the manufacture of oil gases approaching the combustion characteristics of natural gas or of lower heating value mixed gases.

### Experimental

A 2.47-in. inside diameter, externally heated cracking tube with a concentrically placed 1.05-in. outside diameter thermowell was used in this investigation. The free volume of the heated section was 0.115 cu. ft. and four independently controlled electrical heating elements were used. Oil was introduced through a low-pressure gas atomizing nozzle. The base (carrier) gas was generally used for atomization. When no base gas was used, the oils were preheated under pressure in a recirculating pumping system and flashed through the nozzle to the lower tube pressure.

Base gases included hydrogen, carbon monoxide, methane, ethylene, recirculated oil gas, steam, nitrogen and mixtures thereof. Only hydrogen and the hydrocarbon gases were found to be active in the temperature range investigated, with the other constituents acting as inert diluents. A more complete description of the equipment and operating procedure has been presented[7].

The gases produced contained paraffins and unsaturates with an average carbon number of less than 1.3 and 2.6 respectively. The gas analyses used in the interrelationships developed in this study were obtained with a modified Orsat apparatus* developed by the Institute of Gas Technology. Ethylene and the higher olefins were determined separately and a carbon number of 3.5 was assumed for the higher unsaturates based on average values from mass spectrometer analyses.

Small concentrations of benzene, toluene, butadiene and cyclopentadiene were shown to be present by periodic mass spectrometer check-analyses. It appeared that these constituents were removed with the olefins in the absorption-combustion analyzer and the designation "unsaturates" as it will be used here refers to this mixture of unsaturated hydrocarbons.

Ultimate analyses of oils were determined on a macro scale by an adaptation of ASTM method D 271-44 according to the Millin Technique[3].

### Interrelationship of Partial Pressures of Gaseous Cracking Products

In Table 1, experimental partial pressure products of the gaseous paraffins and unsaturates and of the hydrogen formed in oil gasification are given for a wide range of cracking temperature, total pressure, partial pressures of active constituents and residence time.

From these data it appears that the concept of the partial pressure product constant which has been formulated recently[7] in terms of a "pseudo equilibrium constant" appears valid for oil gases produced from all types of petroleum oils and hydrocarbons under cracking conditions of sufficient severity to give essentially complete conversion, that is, operating conditions typical of manufactured gas practice. This constant ($K_p$) expressed in terms of mol % of the gaseous constituents and the total pressure ($P$) in atmospheres is defined as:

$$K_p = P \frac{(H_2)^2 (U)}{100 (S)^2} \qquad (1)$$

where $U$ and $S$ are the mol % of unsaturates ("olefins" or "illuminants")

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* Mr. Linden is supervisor, oil gasification section, Institute of Gas Technology, Chicago. Note: This study was undertaken as part of the project "Oil Gasification" sponsored by the Gas Production Research Committee of the American Gas Association, at the Institute of Gas Technology under the PAR plan.

*Multiple combustions over promoted copper oxide for carbon monoxide, hydrogen and paraffin determinations[8]. 87% $H_2SO_4$ for higher olefins and acid mercuric sulfate reagent[3] for ethylene determinations.

**Table 1—Partial Pressure Product Constants for the Gaseous Cracking Products of Hydrocarbons**

| Run No. | C/H Ratio of Oil or Feed Hydroc. | Hydrogen to Oil (Hydroc.) Feed Ratio SCF/Lb. h/w | Resid. Time Secs. τ | Total Pressure Atm. P | Cracking Temp., °F Ave. Max. t | Ave. Tube | Gas Composition Vol. % Paraff. S | $CH_4$ Equiv. a | Vol. % Unsats. U | $C_2H_4$ Equiv. q | Vol. % Hydrogen $H_2$ | $K_p' = \frac{P(H_2)^2(C_2H_4)}{100(S)^2}$ | Hydrogen in Exit Gas, SCF/Lb. Oil or Feed Hydrocarbon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 166 | 7.05 | 0.00 | 1.70 | 1.03 | 1410 | 1340 | 50.9 | 1.25 | 30.3 | 1.32 | 8.7 | .025 | 0.93 |
| 213 | 8.47 | 0.00 | 2.33 | .304* | 1400 | 1390 | 41.3 | 1.18 | 41.4 | 1.29 | 14.4 | .015 | 0.81 |
| 169 | 6.39 | 0.00 | 2.74 | 1.03 | 1400 | 1350 | 50.0 | 1.30 | 31.3 | 1.27 | 9.1 | .030 | 1.14 |
| 154 | 7.05 | 0.00 | 2.95 | 1.04 | 1400 | 1310 | 45.9 | 1.25 | 37.9 | 1.10 | 12.0 | .027 | 0.93 |
| 149 | 7.05 | 0.00 | 3.13 | 1.04 | 1400 | 1350 | 29.1 | 1.19 | 25.0 | 1.29 | 9.7 | .029 | 1.22 |
| 191* | 8.47 | 0.00 | 3.13 | .663* | 1400 | 1350 | 47.5 | 1.17 | 34.5 | 1.30 | 14.2 | .020 | 0.80 |
| 96 | 5.64 | 0.00 | 3.14 | 1.01 | 1420 | 1360 | 48.9 | 1.18 | 35.5 | 1.13 | 14.3 | .031 | 1.66 |
| 158 | 7.05 | 0.00 | 5.05 | 1.00 | 1400 | 1380 | 38.7 | 1.18 | 25.6 | 1.14 | 12.2 | .025 | 1.35 |
| 172 | 6.39 | 0.00 | 5.15 | 1.00 | 1400 | 1390 | 34.7 | 1.15 | 27.6 | 1.21 | 9.6 | .021 | 1.15 |
| 77 | 5.2 | 0.00 | 8.54 | 2.33 | 1400 | 1360 | 65.2 | 1.15 | 20.4 | 1.07 | 14.0 | .022 | 1.85 |
| 97 | 5.64 | 0.00 | 9.34 | 2.73 | 1420 | 1350 | 64.2 | 1.12 | 19.8 | 1.07 | 14.0 | .026 | 1.51 |
| 95 | 5.64 | 0.00 | 11.6 | 2.65 | 1400 | 1370 | 66.1 | 1.12 | 19.3 | 1.10 | 13.7 | .022 | 1.47 |
| 200 | 5.3 | 0.00 | 13.6 | 3.97 | 1400 | 1360 | 67.9 | 1.14 | 16.0 | 1.13 | 14.2 | .028 | 1.54 |
| 76 | 5.2 | 0.00 | 13.7 | 4.20 | 1400 | 1340 | 74.1 | 1.13 | 12.2 | 1.09 | 12.7 | .015 | 1.63 |
| 157 | 7.05 | 0.00 | 1.62 | 1.04 | 1550 | 1480 | 29.7 | 1.15 | 19.5 | 1.15 | 16.4 | .062 | 2.35 |
| 33 | 7.15 | 1.0 | 2.26 | 1.00 | 1550 | 1550 | 5.4 | 1.22 | 6.2 | 1.14 | 4.4 | .041 | 2.6 |
| 28 | 7.15 | 1.0 | 2.35 | 1.00 | 1550 | 1550 | 6.2 | 1.00 | ≈1 | 1.05 | 5.3 | .045 | 2.3 |
| 70 | 7.59 | 1.4 | 2.37 | 1.01 | 1560 | 1510 | 4.9 | 1.18 | 4.9 | 1.04 | 5.5 | .062 | 3.4 |
| 170 | 6.39 | 0.00 | 2.57 | 1.03 | 1550 | 1480 | 36.4 | 1.11 | 21.0 | 1.06 | 16.3 | .043 | 2.42 |
| 98 | 5.64 | 0.00 | 2.62 | 1.01 | 1560 | 1520 | 22.8 | 1.19 | 15.8 | 1.05 | 13.5 | .056 | 3.25 |
| 147 | 7.05 | 0.00 | 2.67 | 1.02 | 1550 | 1460 | 32.0 | 1.09 | 17.8 | 1.10 | 18.5 | .061 | 2.62 |
| 153 | 7.05 | 0.00 | 2.68 | 1.02 | 1550 | 1470 | 50.2 | 1.10 | 24.8 | 1.11 | 22.5 | .054 | 2.23 |
| 84 | 7.00 | 0.7 | 2.78 | 2.86 | 1550 | 1490 | 10.6 | 1.07 | 7.3 | 1.08 | 7.5 | .075 | 3.1 |
| 79 | 7.59 | 0.3 | 2.87 | 1.02 | 1550 | 1500 | 21.3 | 1.05 | 9.4 | 1.06 | 18.5 | .072 | 3.7 |
| 60* | 6.39 | 0.00 | 2.88 | .474* | 1550 | 1500 | 40.6 | 1.13 | 31.5 | 1.10 | 25.6 | .059 | 2.80 |
| 212* | 8.47 | 0.00 | 2.98 | .879* | 1550 | 1440 | 49.9 | 1.05 | 21.0 | 1.13 | 26.4 | .052 | 2.00 |
| 82 | 7.59 | 1.1 | 4.54 | 2.59 | 1550 | 1530 | 7.9 | 1.15 | 3.1 | 1.07 | 7.0 | .063 | 4.2 |
| 156 | 7.05 | 0.00 | 4.71 | .994 | 1550 | 1540 | 34.7 | 1.14 | 14.5 | 1.08 | 21.7 | .056 | 3.07 |
| 81 | 7.59 | 0.3 | 5.50 | 1.01 | 1550 | 1550 | 22.7 | 1.16 | 8.1 | 1.07 | 21.4 | .073 | 4.2 |
| 88-B | 7.00 | 0.2 | 10.79 | 3.34 | 1550 | 1500 | 38.2 | 1.04 | 3.8 | 1.04 | 21.8 | .041 | 3.8 |
| 88-C | 7.00 | 0.3 | 11.17 | 3.61 | 1550 | 1500 | 35.8 | 1.03 | 3.4 | 1.02 | 21.4 | .044 | 4.0 |
| 184* | 7.05 | 0.00 | 2.39 | .668* | 1700 | 1660 | 39.1 | 1.07 | 11.5 | 1.02 | 44.8 | .101 | 5.73 |
| 171 | 6.39 | 0.00 | 2.46 | 1.02 | 1700 | 1640 | 33.8 | 1.00 | 8.9 | 1.05 | 31.4 | .078 | 5.98 |
| 148 | 7.05 | 0.00 | 2.55 | 1.01 | 1700 | 1660 | 28.2 | 1.05 | 6.2 | 1.17 | 34.3 | .095 | 6.25 |
| 190* | 8.47 | 0.00 | 2.61 | .709* | 1700 | 1650 | 36.3 | 1.00 | 7.0 | 1.20 | 49.2 | .091 | 5.64 |
| 110 | 7.59 | 0.00 | 2.64 | 1.10 | 1720 | 1660 | 20.0 | 1.11 | 4.8 | 1.08 | 33.4 | .147 | 6.78 |
| Propane** | 4.47 | 0.00 | 10-20 | Approx. 1.0 | 1472 | .... | 53.2 | 1.27 | 26.0 | 1.06 | 20.8 | .040 | 3.67 |
| | 4.47 | 0.00 | 10-20 | Approx. 1.0 | 1562 | .... | 54.1 | 1.15 | 19.3 | 1.06 | 26.6 | .047 | 4.72 |
| | 4.47 | 0.00 | 10-20 | Approx. 1.0 | 1742 | .... | 48.3 | 1.14 | 7.7 | 1.03 | 44.0 | .064 | 9.24 |
| Ethylene*** | 5.96 | 0.00 | 10-20 | Approx. 1.0 | 1472 | .... | 46.0 | 1.17 | 34.4 | 1.07 | 19.6 | .062 | 2.34 |
| | 5.96 | 0.00 | 10-20 | Approx. 1.0 | 1562 | .... | 52.2 | 1.06 | 12.5 | 1.02 | 35.3 | .057 | 4.83 |
| | 5.96 | 0.00 | 10-20 | Approx. 1.0 | 1652 | .... | 50.8 | 1.04 | 4.1 | 1.03 | 45.1 | .032 | 6.90 |

* Steam used as diluent; total pressure values correspond to partial pressures of components other than steam; gas analyses are on a steam-free basis.
** Hague, E. N. and Wheeler, R. V., Journal Chemical Soc., 378 (1928).
*** Wheeler, R. V. and Wood, W. L., Journal Chemical Soc., 1819 (1930).

and paraffins (saturates) respectively. Ideal gas behavior is assumed. Equation (1) is based on the assumption that the paraffins-unsaturates-hydrogen system is equivalent to the methane-ethylene-hydrogen system ($2CH_4 \rightleftharpoons C_2H_4 + 2H_2$).

The exponents of the mol % in Equation (1) were therefore chosen to correspond to the partial pressure product characterizing the methane-ethylene-hydrogen equilibrium:

$$K_p' = P\frac{(H_2)^2\,(C_2H_4)}{100\,(CH_4)^2}$$

The assumption that the paraffins were equivalent to methane and the unsaturates to ethylene closely approximated actual results since the average carbon numbers were generally below 1.2 for the paraffins and 2.4 for the unsaturates.

The average value of $K_p$ for the data of Table 1 is 0.024 at 1400° F., 0.056 at 1550° F. and 0.102 at 1700° F. These values approximately fit the standard empirical expression: $\log K_p = A/T + B$. For this case:

$$\text{Log } K_p = -\frac{8{,}500}{T} + 2.96 \qquad (1a)$$

where $T$ is the temperature in degrees Rankine. Thermal cracking data for $C_2$ to $C_4$ paraffins and olefins as reported by Hague and Wheeler[5] and Wheeler and Wood[12] again agree moderately well. Partial pressure product constants calculated from oil cracking data of White[10] and Groll[9] show better agreement.

The values of $K_p'$ calculated from the standard free energy data for the system: $2\,CH_4 \rightleftharpoons C_2H_4 + 2H_2$ are considerably lower than values of $K_p'$ obtained in thermal cracking but approach more closely at the higher temperatures corresponding to increasing depths of cracking. Such a deviation is expected since the latter is not an equilibrium but rather a relatively stationary state in a sequence of cracking reactions.

This means that the partial pressure product constant is an empirical parameter although it has the mathematical form and many other properties of an equilibrium constant. Within the narrow limits of residence time considered here the relative quantities of the three groups of gaseous constituents and the total mass of the gas phase will vary with residence time while the partial pressure product remains constant as carbon and high molecular weight polymerization and cracking products are formed. Further, the effects of the higher paraffins and olefins and of the gaseous aromatics (primarily benzene) which are always present in such a system were not taken into consideration.

Additional confirmation of the validity of the proposed relationship was obtained from cracking tests of a 7.05 C/H ratio residual oil at 4 to 5 sec. residence time and 1550° F. in the presence of methane, ethylene and hydrogen (See Table 2). The value of $K_p'$ for this temperature calculated from Equation (1a) is 0.054. It can be seen that in the presence of each one of the three major cracking products in quantities which would normally be produced in inert cracking atmospheres (see data for nitrogen in Table 2) a close approach to pseudo-equilibrium conditions is made.

However, molecular hydrogen and methane were found to be relatively unreactive as indicated by the deviations of the experimental values of $K_p'$ for the corresponding runs. In these tests methane appeared to be least reactive. No shift of $K_p'$ was observed in the presence of recirculated oil gas.

Of further significance are the re-

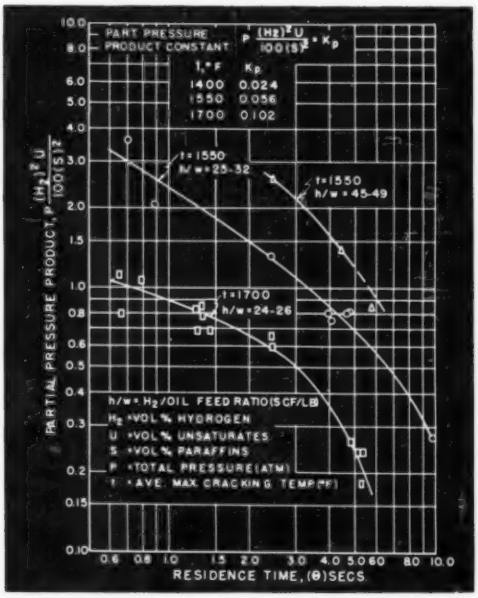
PART PRESSURE PRODUCT CONSTANT
P (H2)² U / 100(S)² = Kp
T, °F Kp
1400 0.024
1550 0.056
1700 0.102
t = 1550 h/w = 25-32
t = 1550 h/w = 45-49
t = 1700 h/w = 24-26
h/w = H2/OIL FEED RATIO (SCF/LB)
H2 = VOL % HYDROGEN
U = VOL % UNSATURATES
S = VOL % PARAFFINS
P = TOTAL PRESSURE (ATM)
T = AVE. MAX. CRACKING TEMP (°F)
PARTIAL PRESSURE PRODUCT, P (H2)² U / 100(S)²
RESIDENCE TIME, (θ) SECS.

**FIG. 1** — Approach to partial pressure product constant in presence of molecular hydrogen

sults for the Btu recovery in the product gas per pound of oil fed. Taking the value for the nitrogen atmosphere as the norm, the values for the methane and hydrogen atmospheres are approximately 700 Btu/lb. higher and the value for the ethylene atmosphere is 1500 Btu/lb. lower. These results were predictable from the relationship of Equation (1) in the following manner:

In the presence of methane, the methane formation from the oil is suppressed and more ethylene is formed. Since more carbon from the oil can be gasified as ethylene than as methane for a given available hydrogen content (that is a given C/H ratio) the Btu recovery should be higher. Conversely, in the presence of ethylene, ethylene formation from the oil is depressed, less carbon can be gasified as methane for a given C/H ratio and a lower Btu recovery results. The well established effect of gaseous hydrogen causing suppression of hydrogen formation from the oil (or actually hydrogen absorption at sufficiently high partial pressures) and thereby increasing the total gasification of hydrocarbons completes the picture.[2, 7, 10]

It is now also possible to find a theoretical justification for the use of the variable of hydrogen to oil feed (h/w) which has been employed extensively in the work on carbureted water gas manufacture.[2, 7, 10]

By plotting the experimental partial pressure product against residence time at various cracking temperatures, the deviation from the corresponding partial pressure product constant ($K_p$) is found to be a function of residence time and of molecular hydrogen feed per unit weight of hydrocarbon (see Fig. 1). It can be seen that the value of $K_p$ is approached more rapidly at the higher temperatures due to the more rapid reaction rate of the molecular feed hydrogen with the system.

Cracking test results for a heavy gas oil using a 2-in. diameter silica tube reported by Willien[15] at residence times from 0.3 to 8 sec., over a wide range of temperatures agree well with these plots.

### Relationship of the Paraffin to Unsaturates Ratio, Cracking Conditions, and Oil or Feed Hydrocarbon Properties

It has been shown that in inert cracking atmospheres as a function of the partial pressures of the gaseous products of high-temperature vapor-phase cracking of hydrocarbons depends only on the cracking temperature (similar to an equilibrium constant) at residence times above one second, cracking temperatures from 1400 to 1700° F., and for hydrocarbon feed stocks ranging from natural gasolines to Bunker C fuel oils. It has also been shown that in the presence of excess molecular feed hydrogen the deviation from this function is determined by the hydrogen to hydrocarbon feed ratio, the residence time and the cracking temperature. The variable of hydrogen to oil feed ratio was considered in order to make the results of this work generally applicable to fuel gas manufacture.

To extend these relationships to the estimation of gaseous product distribution, an empirical correlation between the paraffin-unsaturates ratio and operating variables characterizing conditions employed in the manufactured gas industry was developed. Because of its somewhat greater reproducibility, the equivalent methane-ethylene ratio ($nS/qU$) was used here as a criterion, where $n$ is the paraffin carbon number or $CH_4$-equivalent and $q$ is one-half of the unsaturates carbon number or $C_2H_4$-equivalent.

The values of equivalent methane-ethylene and of paraffin-unsaturates ratios are approximately the same since the quotient $n/q$ is near unity in the 1400-1700° F. cracking temperature range. Cracking conditions and oil feed or hydrocarbon properties were characterized by the C/H ratio of the feed stock, the partial pressure of the oil gas leaving the cracking zone ($Px$ in atmospheres where $P$ is the total pressure and $x$ the mol or volume fraction of oil gas based on the total volume of the

**Table 2—The Effects of Addition of Gaseous Cracking Products on Oil Gasification**

| Cracking Temp., °F | Resid. Time, Secs. | Total Press., Atmos. P | Base Gas | Base Gas to Oil Feed Ratio SCF/Lb. | Make (Exit) Gas Composition, Vol. % Paraff. S | Unsats. U | Hydrogen $H_2$ | $K_p = \frac{P(H_2)^2 U}{100(S)^2}$ | Net Gas Yields, SCF/Lb. Paraff. | Unsats. | $H_2$ | Btu Recovery per Lb. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1550 | 1.71 | 0.991 | $N_2$ | 3.68 | 34.7 | 14.5 | 21.7 | 0.056 | 4.91 | 2.05 | 3.07 | 10,420 |
| 1550 | 1.43 | 1.01 | Technical Ethylene* | 2.52 | 48.4 | 22.0 | 24.3 | 0.056 | 6.06 | 0.51 | 3.11 | 8,920 |
| 1550 | 1.30 | 1.02 | Technical Methane** | 4.25 | 59.2 | 14.9 | 23.4 | 0.024 | 4.84 | 2.23 | 3.50 | 11,120 |
| 1550 | 1.16 | 1.02 | Hydrogen | 3.31 | 46.0 | 17.6 | 34.7 | 0.102 | 5.95 | 2.28 | 1.18 | 11,090 |
| 1550 | 2.68 | 1.02 | Recirculated Oil Gas | 1.03 | 50.2 | 24.8 | 22.5 | 0.051 | 4.98 | 2.46 | 2.23 | 10,670 |

* 91.7% Olefins, 5.3% Paraffins, 3.0% Inerts
** 99.4% Paraffins, 0.6% Inerts

gases leaving the cracking zone including steam), the average maximum cracking temperature ($t$ in °F.), the residence time ($\theta$ in seconds), and the hydrogen to oil feed ratio (h/w in SCF/lb. of oil).

The hydrogen to oil feed ratio is equal to zero in many gasification processes such as high Btu oil gas manufacture,[6, 12] but was included to permit wider generalization. The mol or volume fraction of oil gas was based on the total make gas analysis corrected for steam present in gaseous form during cracking. Oil gas was defined as the paraffins ($S$), unsaturates ($U$) and any net hydrogen produced from the oil or other feed hydrocarbon. The other constituents of the make gas, including quantities of hydrogen not produced by cracking, were considered diluents.

The residence time was calculated by assuming the ideal gas law and was based on the make gas rate including steam in gaseous form, the free volume of the cracking zone and the average cracking temperature and pressure. This represents a considerable idealization since it assumes instantaneous cracking of the feed hydrocarbon or oil to the final product volume. (The difference between the average tube temperature and the average maximum temperature in the tube usually did not exceed 60°F.) Simplified methods for estimating the variables listed above for industrial manufactured gas operation have been presented.[7, 10]

From 177 sets of cracking data for a variety of gasolines, fuel oils, residuums and other petroleum fractions and a wide range of cracking conditions, an empirical correlation of the C/H ratio of the oil, the operating variables and the paraffin-unsaturates ratio of the gaseous cracking products was developed by graphical methods. The result is shown in Fig. 2 and in Equations (2) and (3) below.

$$F = \frac{nS/qU}{\log Px} - \left(\frac{525}{1900 - t}\right) \qquad (2)$$

where:

$$R = 0.0124\ (C/H)^2 + (0.272 - 0.00016\ t)\ h/w + 0.40 \qquad (3)$$

It was found that by plotting $F$ versus the residence time ($\theta$), a family of curves resulted with each curve characteristic of a given cracking temperature ($t$). In Fig. 2 this plot is shown. The curves drawn through the data as plotted in Fig. 2 were found to fit the expression:

$$F = \frac{585}{1850 - t} + \left(\frac{72\,\theta}{1930 - t}\right)^3$$

Solution for the paraffin-unsaturates ratio as a function of C/H ratio and operating variables was then possible:

$$nS/qU = \left[F + \left(\frac{525}{1900 - t}\right) \log Px\right] R \qquad (4)$$

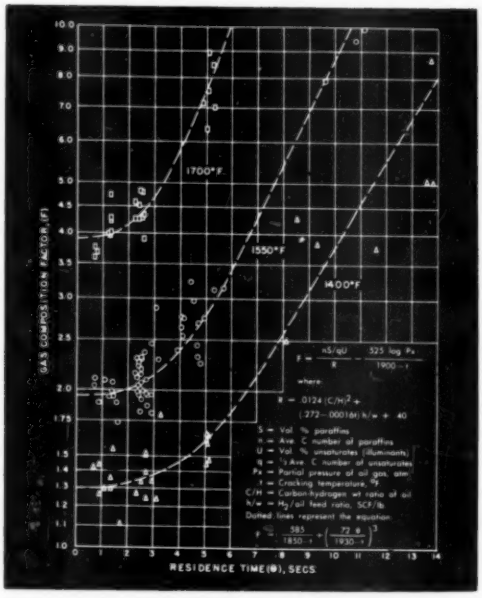
GAS COMPOSITION FACTOR (F)
RESIDENCE TIME (θ), SECS.
1700°F.
1550°F
1400°F
nS/qU
525 log Px
1900 − t
where:
R = .0124 (C/H)² +
(.272 − .00016t) h/w + .40
S = Vol. % paraffins
n = Ave. C number of paraffins
U = Vol. % unsaturates (illuminants)
q = ½ Ave. C number of unsaturates
Px = Partial pressure of oil gas, atm.
t = Cracking temperature, °F.
C/H = Carbon-hydrogen wt ratio of oil
h/w = H₂/oil feed ratio, SCF/lb.
Dotted lines represent the equation
F = 585/(1850 − t) + (72 θ/(1930 − t))³

**FIG. 2**—Correlation of oil gas composition with C/H ratio of oil and operating conditions

For practical application, $nS/qU$ can be read from the nomograph of Fig. 3. In Fig. 4, a comparison of actual and estimated paraffin-unsaturates ratios in the 1400° F. to 1700° F. cracking temperature range is given for 177 sets of oil cracking data with petroleum oils ranging from natural gasoline to Bunker C fuel oils (C/H ratios from 5.2 to 9.2) for residence times from 0.7 to 14 sec., hydrogen to oil feed ratios from 0 to 90 SCF/lb., total pressures from 1.0 to 4.2 atmospheres and partial pressures of oil gas from 0.1 to 4.2 atmospheres. The arithmetic average deviation for these 177 sets of data is 12%.

Selected results for a variety of operating conditions are given in Table 3. Agreement with very limited literature data appears satisfactory but a much lower degree of accuracy must generally be expected when applying this correlation to data obtained in other cracking equipment because of uncertainties in measurement of cracking temperatures and calculation of residence times. Difference in surface and shape of the cracking zone are also expected to reduce reproducibility between various cracking units.

The gaseous product distribution when cracking a hydrocarbon at high temperature in the vapor-phase within the limits of operating conditions noted above can be estimated for the following two cases:

1. Cracking in hydrogen-containing atmospheres at hydrogen to oil (hydrocarbon) feed ratios (h/w) sufficiently high to prevent net hydrogen production.
2. Cracking in inert atmospheres (CO, $CO_2$, $N_2$ and Steam), in the presence of recirculated oil gas or in the absence of diluents.

The first case reduces to the determination of the paraffin-unsaturates ratio (Equation 4) and is of importance only in the manufacture of carburetted water gas. It was found in the investigation of gasification in hydrogen-containing atmospheres that no net hydrogen is produced from liquid petroleum fractions if the hydrogen to hydrocarbon feed ratio (h/w) is above 5 SCF/lb. at 1400° F., 10 SCF/lb. at 1550° F. and 25 SCF/lb. at 1700° F. in the 1 to 6 sec. residence time range and at partial pressures of oil gas from 0.1 to 1.0 atmospheres. This range of operating conditions covers that normally encountered in gas manufacturing practice.

The second case (h/w = 0), applicable to oil gas production[6, 12] and various processes for the production of olefins and aromatics, can be treated as follows: Denoting $S$, $U$ and $H_2$ as the volume percentages of paraffins, unsaturates and hydrogen respectively in the total product gas obtained by thermal cracking of hydrocarbons in the presence of varying

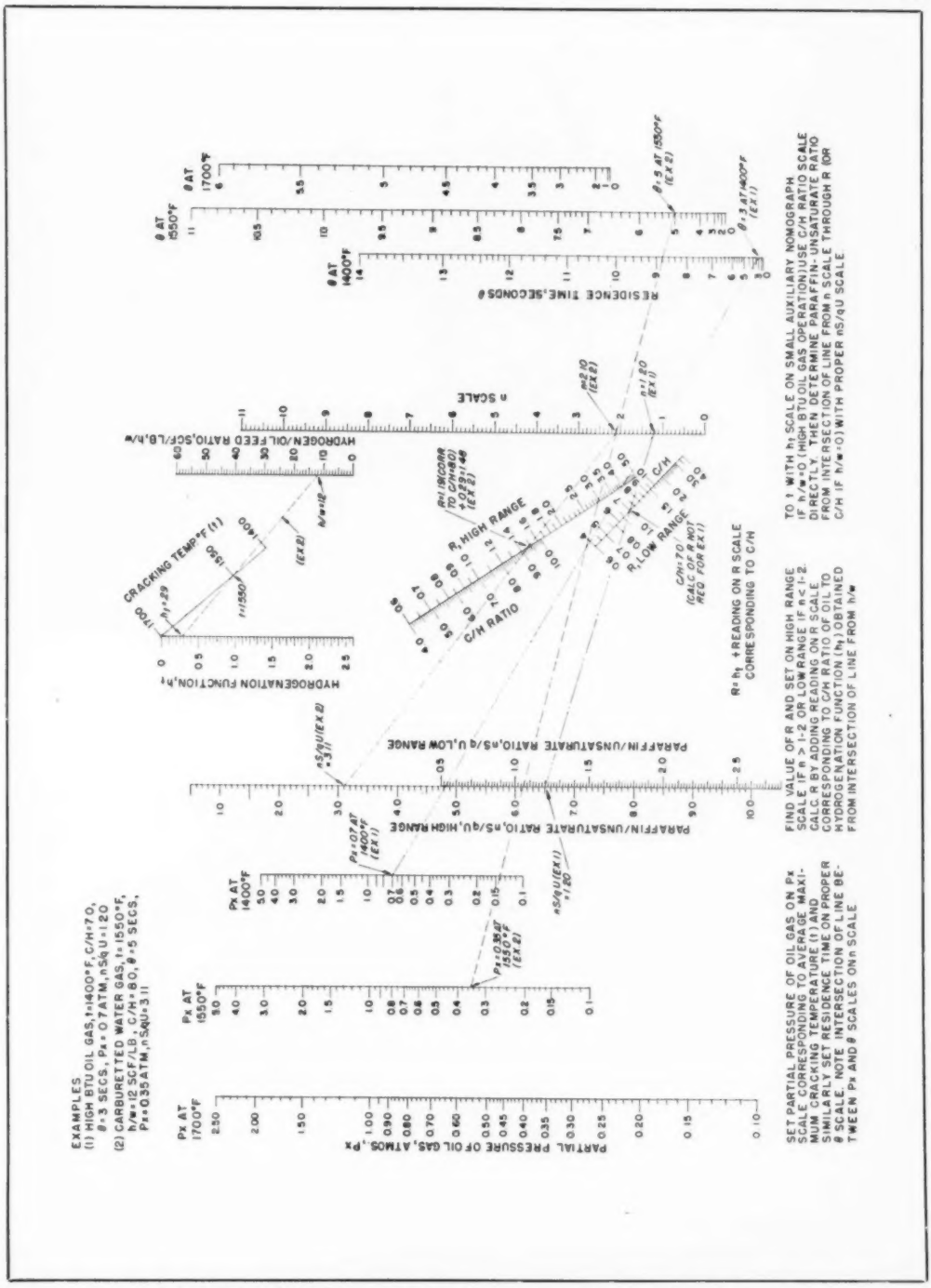
EXAMPLES
(1) HIGH BTU OIL GAS, t=1400°F, C/H=7.0, θ=3 SECS, Px=0.7 ATM, nSQU=1.20
(2) CARBURETTED WATER GAS, t=1550°F, h/w=12 SCF/LB, C/H=8.0, θ=5 SECS, Px=0.35 ATM, nSQU=3.11
PARTIAL PRESSURE OF OIL GAS, ATMOS, Px
Px AT 1700°F
Px AT 1550°F
Px AT 1400°F
PARAFFIN/UNSATURATE RATIO, nS/q u, HIGH RANGE
PARAFFIN/UNSATURATE RATIO, nS/q u, LOW RANGE
HYDROGENATION FUNCTION, hf
CRACKING TEMP °F (t)
HYDROGEN/OIL FEED RATIO, SCF/LB, h/w
n SCALE
RESIDENCE TIME, SECONDS θ
θ AT 1700°F
θ AT 1550°F
θ AT 1400°F
R, HIGH RANGE
R, LOW RANGE
C/H RATIO
SET PARTIAL PRESSURE OF OIL GAS ON Px SCALE CORRESPONDING TO AVERAGE MAXIMUM CRACKING TEMPERATURE (t) AND SIMILARLY SET RESIDENCE TIME ON PROPER θ SCALE. NOTE INTERSECTION OF LINE BETWEEN Px AND θ SCALES ON n SCALE
FIND VALUE OF R AND SET ON HIGH RANGE SCALE, IF n > 1·2 OR LOW RANGE IF n < 1·2. CALC. R BY ADDING READING ON R SCALE CORRESPONDING TO C/H RATIO OF OIL TO HYDROGENATION FUNCTION (hf) OBTAINED FROM INTERSECTION OF LINE FROM h/w
R = hf + READING ON R SCALE CORRESPONDING TO C/H
TO ? WITH hf SCALE ON SMALL AUXILIARY NOMOGRAPH IF h/w = 0 (HIGH BTU OIL GAS OPERATION) USE C/H RATIO SCALE DIRECTLY. THEN DETERMINE PARAFFIN-UNSATURATE RATIO FROM INTERSECTION OF LINE FROM n SCALE THROUGH R (OR C/H IF h/w = 0) WITH PROPER nS/qU SCALE

**FIG. 3—NOMOGRAPH** for estimating the paraffin/unsaturates ratio of oil gases

quantities of inerts such as steam, the following simultaneous equations can be set up ($x$ is the actual mol or volume fraction of $S + U + H_2$ in the exit gas including steam in gaseous form):

$$K_p = P\frac{(H_2)^2 U}{100\,(S)^2} \qquad (1)$$

($K_p$ is a function of temperature as given in Equ. 1a)

$$S + U + H_2 = 100\,x \qquad (5)$$

$$S/U = f\,(t, \theta, C/H, Px) \simeq nS/qU \qquad (4)$$

Substituting Equation (5) into Equation (1) and solving for $U$ and $H_2$ one obtains:

$$U = \frac{100\,x - H_2}{S/U + 1} \qquad (6)$$

and

$$H_2 = \frac{50\sqrt{1 + 4Mx} - 50}{M} \qquad (7)$$

where:

$$M = P\left[\frac{(S/U) + 1}{K_p(S/U)^2}\right]$$

The values of the partial pressure product constant, $K_p = P\,(H_2)^2 U/100\,(S)^2$, ($P$ is the total pressure in atmospheres) are functions of temperature only and can be determined from Equation (1a). The value of $S/U$ can be found from Equation (4) (note that in this case $h/w = 0$). This relationship actually employs the parameter of equivalent methane-ethylene ratio ($nS/qU$). Since $n/q$ is approximately equal to 1 in the 1400 to 1700° F. cracking temperature range, $nS/qU$ is approximately equal to $S/U$. The gaseous product distribution in oil gases produced in the absence of carrier gas hydrogen, such as in high Btu oil gas manufacture, can then be obtained by substituting the proper values of $K_p$ (obtained from the cracking temperature), $S/U$ (Equation 4 or nomograph of Fig. 3), $P$ and $x$ into Equations 5, 6 and 7. For most thermal gasification processes the value of $x$ will depend on the relative volumes of steam and oil gas leaving the cracking zone and can then be defined as:

$$x = \frac{G}{21(s/w) + G}$$

where $G$ is the oil gas yield in SCF per unit weight or volume of feed oil and $s/w$ the pounds of steam fed during the oil admission period per unit weight or volume of feed oil. In high Btu oil gas operation[6, 10, 12] an average value of $G = 60$ SCF gallon of make oil can be assumed.

In cyclic operation or due to other conditions producing non-uniform temperatures, the cracking temperature to be used in calculating $K_p$ and $S/U$ should be determined in the location giving highest time-average temperature (the average maximum temperature). In case of extreme temperature gradients or fluctuations, empirical correlations between results from the proposed method for estimating gaseous product distribution

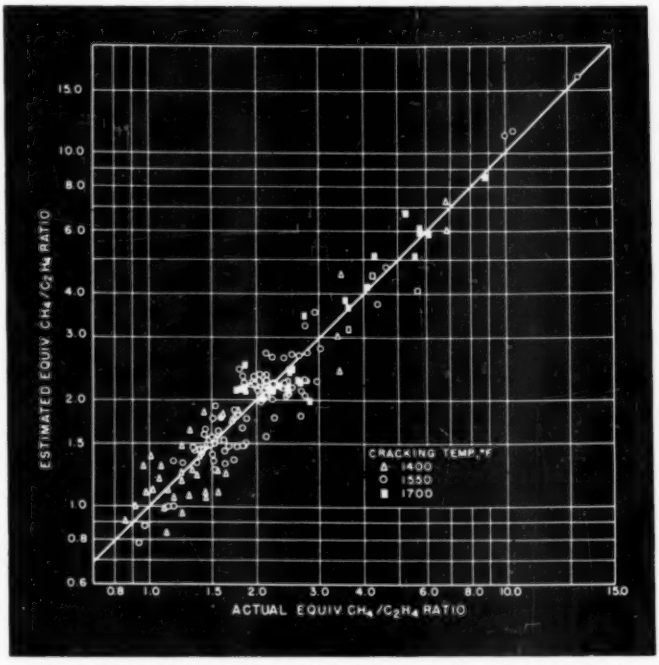


**FIG. 4**—Comparison of actual and estimated paraffin-unsaturates ratios

**Table 3—Test of the Equation for Estimating the Paraffin-Unsaturates Ratio of Oil Gases**

| Run No. | C/H Ratio | Carrier Gas | $H_2$ to Oil Feed Ratio SCF/Lb. $h/w$ | Resid. Time, Sec. | Partial Press. of Oil Gas, Atmos. $Px$ | Cracking Temp., °F $t$ | Hydrocarbons in Make Gas: Paraff. Vol. % $S$ | $CH_4$ Equiv. $n$ | Unsats. Vol. % $U$ | $C_2H_4$ Equiv. $q$ | Vol. % $H_2$ | Paraff.-Unsats. Ratio $nS/qU$ Actual | Estim. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 127 | 6.39 | $CO$-$H_2$ | 23.7 | 1.37 | 0.185 | 1400 | 9.3 | 1.34 | 8.5 | 1.24 | 37.1 | 1.18 | 1.06 |
| 117 | 7.59 | $CO$-$H_2$ | 24.9 | 0.65 | 0.175 | 1700 | 10.6 | 1.11 | 5.8 | 1.12 | 44.8 | 1.81 | 2.16 |
| 198 | 8.47 | $H_2$ | 30.3 | 8.16 | 0.980 | 1400 | 22.5 | 1.26 | 3.5 | 1.19 | 21.7 | 6.81 | 7.30 |
| 199 | 8.47 | $H_2$ | 31.8 | 9.64 | 0.972 | 1550 | 28.6 | 1.04 | 1.5 | 1.20 | 67.8 | 16.5 | 16.4 |
| 32 | 7.59 | $H_2$ | 44.3 | 2.57 | 0.199 | 1550 | 13.8 | 1.11 | 3.9 | 1.08 | 78.9 | 2.41 | 2.23 |
| 69 | 7.59 | $H_2$ | 89.6 | 2.54 | 0.199 | 1550 | 7.8 | 1.18 | 3.1 | 1.05 | 88.0 | 2.78 | 2.06 |
| 213 | 8.47 | Steam | 0.0 | 2.33 | 0.295 | 1400 | 41.3 | 1.18 | 41.4 | 1.29 | 14.4 | 0.91 | 0.99 |
| 184 | 7.05 | Steam | 0.0 | 2.39 | 0.636 | 1700 | 39.1 | 1.07 | 11.5 | 1.02 | 44.8 | 3.57 | 3.88 |
| 156 | 7.05 | $N_2$ | 0.0 | 4.71 | 0.703 | 1550 | 34.7 | 1.14 | 14.5 | 1.08 | 21.7 | 2.53 | 2.48 |
| 148 | 7.05 | $N_2$ | 0.0 | 2.55 | 0.714 | 1700 | 28.2 | 1.05 | 6.2 | 1.17 | 34.5 | 4.08 | 4.12 |
| 154 | 7.05 | Recir. Oil Gas | 0.0* | 2.95 | 0.996 | 1400 | 45.9 | 1.25 | 37.9 | 1.10 | 12.0 | 1.38 | 1.38 |
| 97 | 5.64 | None | 0.0 | 9.34 | 2.67 | 1400 | 64.2 | 1.12 | 19.8 | 1.07 | 14.0 | 3.40 | 3.05 |
| 76 | 5.2 | None | 0.0 | 13.7 | 4.16 | 1400 | 74.1 | 1.13 | 12.2 | 1.09 | 12.7 | 6.86 | 6.16 |

* Hydrogen content of recirculated oil gas not considered.

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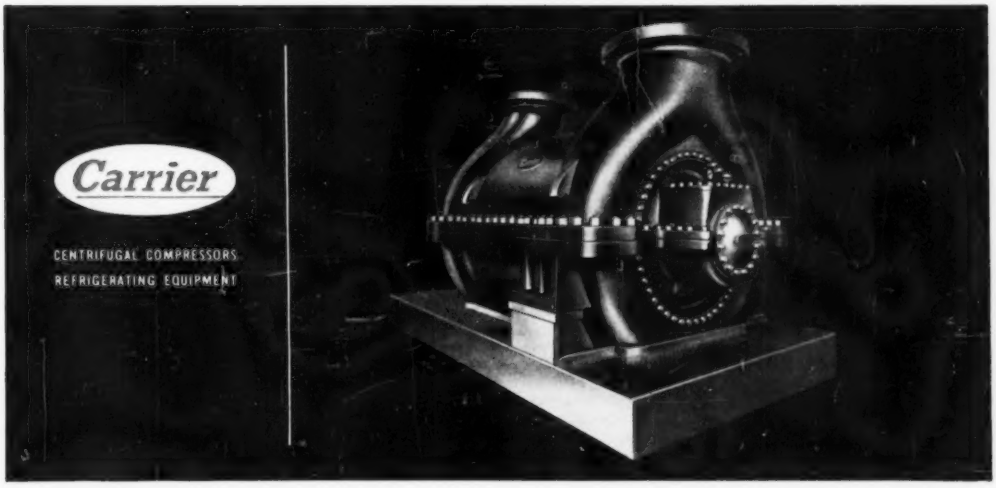


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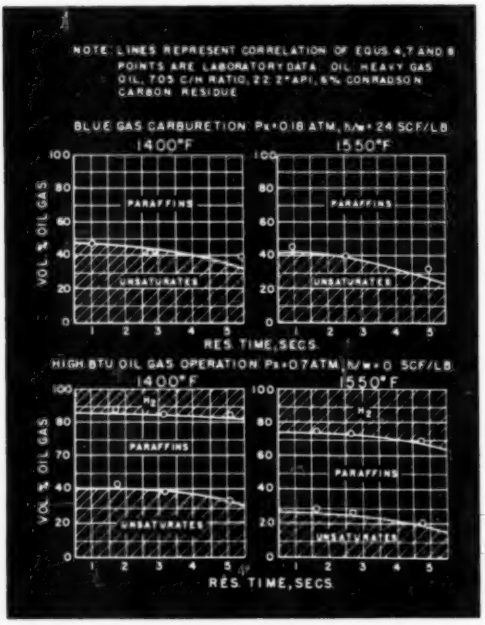


**FIG. 5** — Test of gaseous product distribution correlation for typical manufactured gas operation

and actual results would have to be developed for specific cracking units.

A comparison of laboratory cracking tube and estimated gaseous product distributions for operating conditions typical for (1) carburetted water gas and (2) high Btu oil gas manufacture is shown in Fig. 5 for an oil typical of a widely used grade of gas-making oil (a reduced crude of C/H = 7.05). The oil gas compositions are given on a 100% oil gas basis or hydrogen (only produced in the second case) = $H_2/x$, paraffins = $S/x$ and unsaturates = $U/x$.

## Conclusions

From the data presented here and literature data it appears that at severe cracking conditions and at sufficiently long residence times the distribution of gaseous products of hydrocarbon pyrolysis is relatively independent of the molecular weight and structure of the feed hydrocarbon. The only feed hydrocarbon property exerting a significant influence on gaseous product distribution for this range of cracking conditions is the ultimate analysis, most conveniently expressed in terms of the carbon-hydrogen weight ratio.

In the temperature and residence time range used by the manufactured gas industry, the gaseous products are primarily methane, ethylene and also hydrogen if the relative quantities of base or carrier gas hydrogen and of hydrocarbons fall below critical value determined primarily by the cracking temperature. In the absence of diluents containing any of the major gaseous cracking products the composition of the gas produced complies with a partial pressure relationship between paraffins, unsaturates and hydrogen similar to that expressing the methane-ethylene-hydrogen equilibrium. The partial pressure product constant which characterizes this system is (similar to an equilibrium constant) a function of reaction temperature for cracking temperatures from 1400 to 1700° F., residence times from one to 14 seconds and pressures one to five atmospheres. In the range where the ratio of carrier gas hydrogen to hydrocarbon feed is sufficiently high to prevent a net production of hydrogen or to cause hydrogen absorption, deviations from the partial pressure product constant increase with the hydrogen to oil feed ratio and decrease with the residence time and the cracking temperature.

The composition of gaseous cracking products obtained in high-temperature, vapor-phase cracking of petroleum fractions seems to be determined by the carbon-hydrogen weight ratio of the feed stock, and the cracking temperature, residence time, partial pressure of the gaseous cracking products and, in the presence of gaseous feed hydrogen, the hydrogen to oil feed ratio. Using empirical correlations of these variables and, when applicable, the partial pressure relationship it is possible to estimate gaseous product distribution in terms of total paraffins, unsaturates and hydrogen over a wide range of operating conditions.

## Acknowledgement

Thanks are due to the Gas Production Research Committee of the American Gas Association for releasing this material for publication. E. S. Pettyjohn, Director of the Institute of Gas Technology, participated in all phases of this study and made valuable contributions in the preparation of this paper. The operation of the cracking unit was under the supervision of R. D. Clevenger, Associate Chemist and the presentation of the data and their correlation was reviewed by R. E. Peck, Research Consultant.

### Nomenclature

SCF = Standard cubic foot (at 60° F, 30" of 32° F mercury, saturated with water vapor)
$P$ = Absolute pressure, atmospheres
$H_2$ = Mol percent of hydrogen in product gas
$S$ = Mol percent of paraffins in product gas
$n$ = Average carbon number of paraffins in gaseous products ($CH_4$ equivalents)
$U$ = Mol percent of unsaturated hydrocarbons in product gas
$q$ = Half of average carbon number of unsaturates in gaseous products ($C_2H_4$ equivalents)
$K_p$ = Partial pressure product constant = $(P)\ (H_2)^2(U)/(100)(S)^2$
h/w = Average ratio of volume of free hydrogen in carrier gas fed during gasification period to weight of feed oil or hydrocarbon, SCF/lb.
s/c = Average ratio of weight of carrier steam fed during gasification period to weight or volume of feed oil or hydrocarbon, lb./lb. or lb./gal.
$G$ = Volume of total oil gas (net yield of hydrogen, unsaturates and paraffins) per unit weight or volume of feed oil or hydrocarbon, SCF/lb. or SCF/gal.
C/H = Carbon-hydrogen weight ratio of feed oil or hydrocarbon
$\theta$ = Residence time based on $P$, average temperature in cracking zone and volume of total exit gas (SCF of hydrogen, gaseous hydrocarbons, inert gases and steam) and calculated from ideal gas law, seconds.
$t$ = Average maximum temperature, ° F.
$T$ = Average maximum temperature, ° Rankine
$x$ = Mol fraction of net yields of hydrogen plus gaseous hydrocarbons in exit gas ($H_2 + U + S = 100\ x$)

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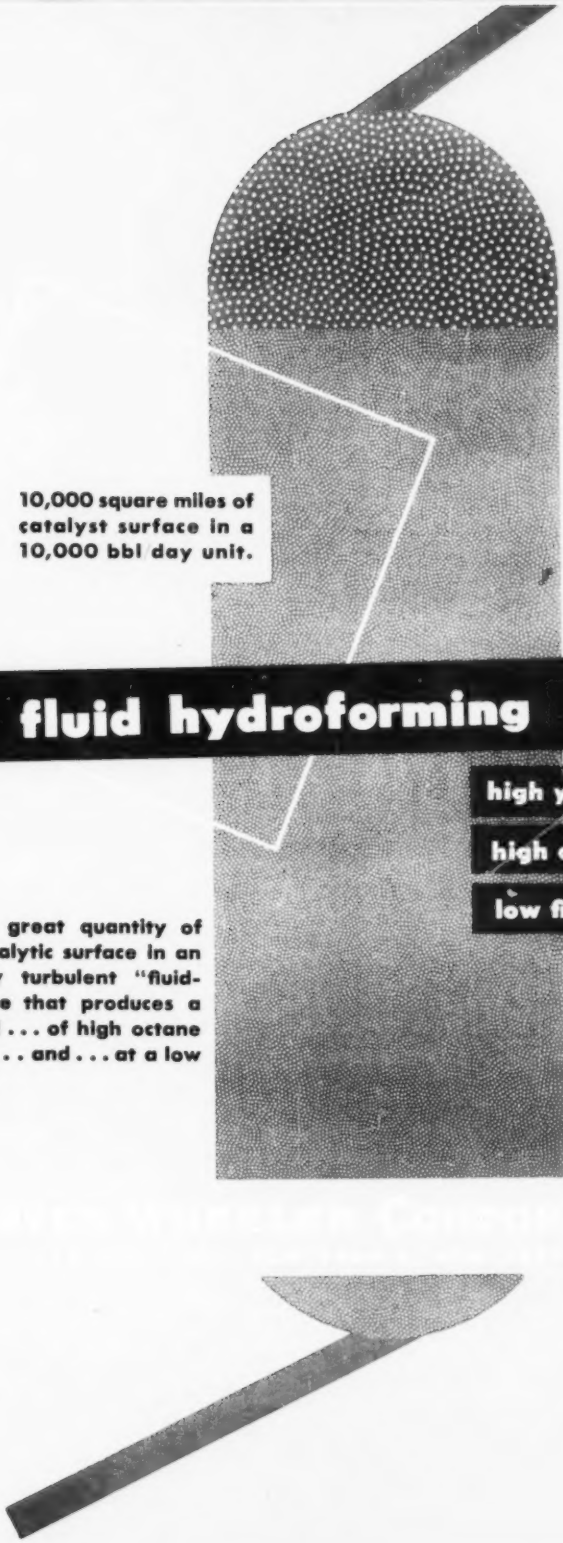

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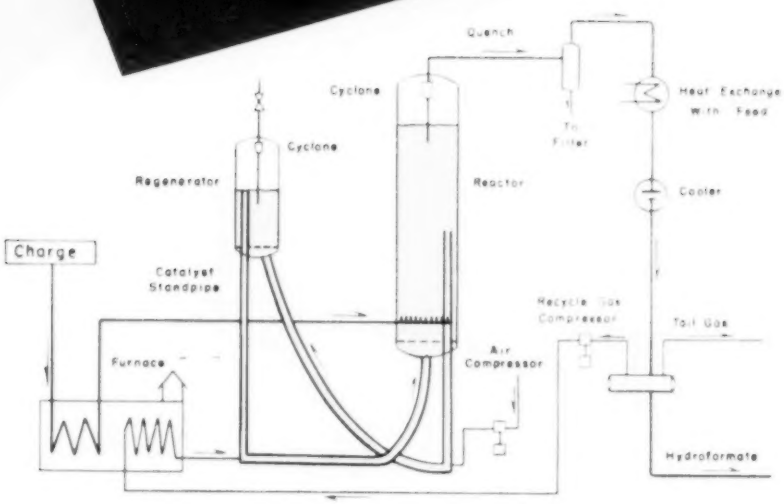


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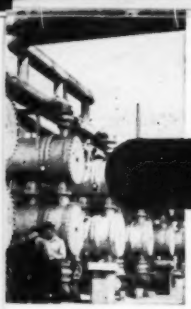


## PLANT PRACTICES

**Practical Tips and Ideas for Improving Operations**

# How to Obtain 24-hr Gas Samples

AN old temperature recorder-controller serves as the basic operating mechanism of a device for obtaining representative 24-hr. gas samples at the Overton, Texas, natural gasoline plant of The Parade Co.

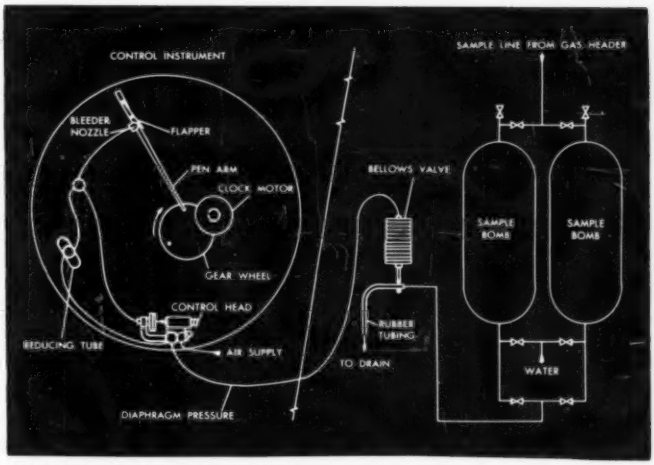
Plant engineers had been having difficulty in sampling by water displacement in 9-gal. sample bombs. Needle valves had been used to adjust the continuous water drain to a fast drip. Too often the needle valves would choke off due to small grains of dirt or rust in the water. After a number of different methods were tried out and discarded as too costly or not practical, the final result was an interval controller using the old temperature instrument, as illustrated.

The electric clock in the instrument was dismantled and all the gears except one removed. The clock motor turns this gear wheel at a rate of one revolution every 6 minutes. A smaller rod was soldered near the outer edge of the gear wheel. The recording pen was removed and a longer pen arm was cut off to the proper length and put on. This pen arm was cut so that it would reach the outer portion of the gear wheel. It was adjusted so it was in the direction of the gear wheel.

Thus, as the clock motor turns the gear, the rod, or pin, comes around every 6 minutes and moves the pen arm a short distance. The pen arm drops back to its normal position as soon as the pin on the gear passes by. The pen arm is connected to the regular pen shaft, which in turn moves the flapper off the air bleeder thus causing the air pilot controller to release the diaphragm pressure.

A diaphragm-type, off-on valve was constructed using the bellows out of the old recorder-controller. The bellows, when expanded, pushes a steel rod against a piece of rubber tubing, closing it off. When diaphragm pressure is released, the bellows contracts allowing the rubber tubing to open. The rubber tubing is connected to the water drain connections on the sample bombs so that water can be drained out each time the bellows contracts.

When the device is in operation, water is automatically drained out of the sample bombs for a few seconds at six-minute intervals. The adjustments for proper operation seemed to be rather critical during the preliminary stages, but once set correctly the time worked very precisely. It has been in operation several months without any additional adjustments. About 120 cc. of water drains from the rubber tubing in approximately 4 secs. as it is now set. This flow is rapid enough to keep the lines flushed out and of course eliminates the clogging experienced previously with the needle valves.




**AUTOMATIC INTERVAL TIMER** for gas sampling is made from an old recorder-controller

The above item is based on a prize-winning idea from the "Operating Kinks" competition at the Southern regional meeting of the Natural Gasoline Ass'n. of America in Tyler, Texas, October 19, 1951. The idea was submitted by Robert G. Patterson, laboratory technician, and Delbert Gray, engineer, with The Parade Co., Overton, Texas.

# How to Clean Vacuum Unit Ejectors

*By J. W. O'KELLEY and B. D. ROBERTS**

CONSIDERABLE savings in labor can be attained by an improved method for cleaning ejectors on a vacuum distillation unit as practiced at the Cushing, Oklahoma, refinery of Deep Rock Oil Corp.

The arrangement of the entire vacuum-producing unit is as follows: Vacuum in the still, at about 26 in. Hg., is obtained by a large booster ejector discharging into the main barometric condenser. Any air or gas present in this barometric condenser is then removed by three two-stage ejectors operating in parallel. Each stage consists of a chamber through which the gas enters and a Venturi nozzle through which the gas leaves. Gas is propelled through the Venturi by a steam jet directed into the nozzle. Between stages of each ejector assembly is a smaller barometric condenser.

The circulating water used in the system is taken from the refinery supply, and it contains a considerable amount of sodium chloride as well as lesser quantities of other compounds. Therefore the water vapor entering the vacuum system contains these

* Mr. O'Kelley is stillman and Mr. Roberts group leader for Deep Rock Oil Corp., at Cushing, Okla.

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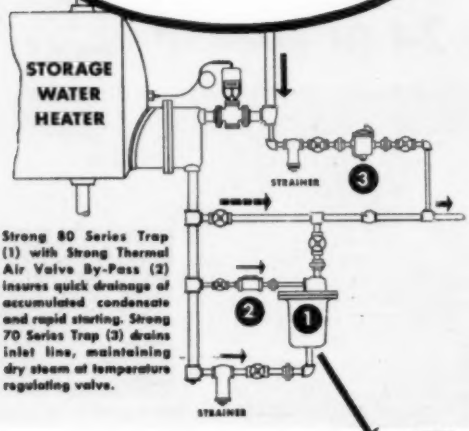


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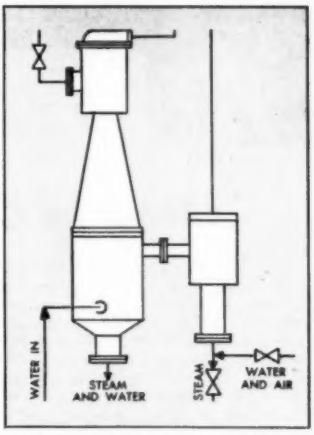


**ARRANGEMENT FOR CLEANING**
ejectors in vacuum still system

salts, which deposit out and coat the inner surface of the Venturi. After this coating builds up—even to a very slight thickness—the ejectors fail to perform properly.

In the past when this occurred, it had been necessary to remove the Venturis completely and clean them by hand. The improved method permit in-place cleaning and is shown in the sketch, as applied to one of the ejectors. The ejector to be cleaned is by-passed from service. Water agitated with air is introduced at the location indicated, and passes through the Venturi to dissolve and remove the coating.

## How to Put Out Fires In Relief Valves on Towers

DUE to frequent electrical storms in the area, the Gregg-Tex Gasoline Corp.'s Longview, Texas, natural gasoline plant is troubled by lightning striking the relief valves on top of the various process towers, causing the valves to leak and igniting the escaping gases. It had been necessary for an operator to climb the tower and put out the fire with a steam hose, a dangerous and unpleasant task in stormy weather.

To reduce this hazard, a $\frac{3}{8}$-in. pipe line was installed to carry steam to the top of the tower and into the discharge line of the relief valve. This steam line parallels the ladder to the top of the tower and then ells over and up into the valve discharge line. The snuffer inside the valve discharge line is made of a $\frac{3}{8}$ x 8-in. nipple, perforated. This nipple is welded into the valve discharge line and extends about 5 in. inside. A $\frac{1}{4}$-in. drain hole is drilled in the bottom of the discharge line.



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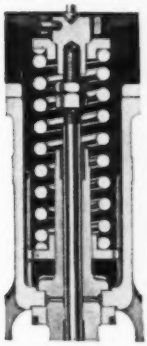

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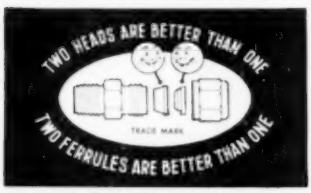


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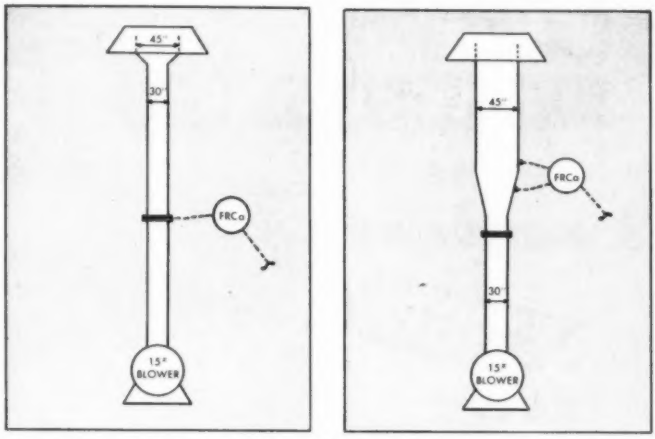
When a relief valve is struck by lightning and the leaking gas ignited, the operator opens a valve on the ¾-in. steam line at the bottom of the tower, quickly snuffing out the blaze. All towers in the plant have had this system installed.

The above item is based on a prize-winning idea from the "Operating Kinks" competition at the Southern regional meeting of the Natural Gasoline Ass'n. of America in Tyler, Texas, October 19, 1951. The idea was submitted by H. L. Baber, chief operator, Gregg-Tex Gasoline Corp., Longview, Texas.




**COMPRESSOR SUCTION LINE REVISED** to increase capacity: original installation at left, revised arrangement at right

# How to Boost Compressor Capacity

*By E. D. MATTIX and R. M. SEE**

REVISING the suction lines to the Fluid catalytic cracking unit air compressors at Cities Service Refining Corp.'s Lake Charles, La., refinery has increased compressor capacity approximately 1½% along with a decrease in horsepower requirements of about 1%. The change was made when our calculations showed that considerable compressor capacity was being lost due to the orifice plate in the suction line.

The previous arrangement, using an orifice plate, is shown in accompanying sketch. Each suction line was 30 in. in diameter and 30 ft. long. A short section of the intake supported the hood over the entrance and was 45 in. in diameter. Air flow to the compressor was measured by an orifice in the suction line about 8 ft. above the compressor inlet nozzle. An orifice with a 0.75 d/D, flange taps, and a meter range of 20 in. water was used. This represented a sizeable loss in air supplied to the compressor.

To reduce pressure loss, the orifice was removed and the length of 45-in. pipe was increased, replacing the 30-in. pipe from the intake to the orifice flanges. The transition piece from the 45 to the 30-in. section of the line was rolled at an angle of 15° with the vertical to form the entrance cone of a venturi. The remaining part of the line was kept to 30-in. diameter, forming a "partial" venturi since there was no recovery cone. However, the lack of the recovery cone did not result in additional pressure loss because the venturi pressure drop also appeared as an entrance loss in the original installation.

Pressure taps were installed above the entrance cone and in the throat below the entrance cone for measuring air intake, using a flow recorder with a range of 10 in. water. The meter factor was calculated by using standard venturi flow calculations. A correction factor was determined after start-up from a test of all meters in the compressor discharge system.

Expressed in terms of the original investment on the Fluid unit, the value of the change was approximately $110,000. The actual cost of the compressor suction line revisions and instrumentation changes was less than $1000 for the two compressors.

*Mr. Mattix is instrument department foreman, Cities Service Refining Corp., Lake Charles, La., refinery. Mr. See is associated with Mr. Mattix in the instrument department.

Above article is based on information contained in a paper, "Refinery Control Problems," presented by Mr. Mattix at the Instrument Conference, Houston, Texas, Sept. 10-14, 1951.

# Faster Maintenance by Radio

FASTER refinery maintenance operations can be attained with costs cut correspondingly by an in-plant radio communications system, judging by the experience of Shell Oil Co. at its sprawling, 1500-acre Wood River, Ill., refinery.

With a set-up of eight transmitter-receivers (two-way) and three receiver-only (one-way) mobile units, a central transmitter-receiver, and a remote control, permanently installed field unit; the 1500-odd, maintenance department employees are covered for the fastest possible expediting of tools, materials, and men around Shell's entire property. There's a lot of territory to cover at Wood River. The 120,000 b/d refinery has some 28 miles of roads inside the fences.

The radio system increases the pay-loads on the shop trucks by 20% as a conservative estimate. This kind of economy results from many factors, notably the decrease in "dead-head" trips—jaunts by empty trucks back to the shop to get their next assignment. With savings like that, it won't take long to pay off the charges for the radio system.

At present, Shell's communication system is described as follows:

I. A central transmitter-receiver at the main tool room.

II. A remote control unit at the engineering field office. This is used by the truck dispatcher on days and by the shift maintenance supervisor and clerks on off-hours.

III. Eleven 30-watt mobile units:

1. A two-way radio with a horn signal relay on a passenger car. This is used by the field foreman of the automotive department during the day shift and by shift maintenance foremen nights, week-ends, and holidays.

2. A two-way radio with horn signal relay on a one-half ton pickup truck. This is used for distribution of craft tools where needed in a hurry during the day shifts. At night this unit is used by the Oil Dispatching Department.

3. A one-way set (receiver only) on the plant's "box pick-up" type truck for unscheduled, nonroutine movements of material and scrap.

4. A one-way set on the tow-and-service truck. This vehicle is used by the automotive department for field maintenance and repairs of mobile equipment such as air compressors, pumps, welding machines, trucks.

5. A one-way set on another one-half ton pick-up truck. This is used during day shifts for general hauling and is assigned to the one shift truck driver at other hours.

6. Six units in ½, ¾, and 1½ ton trucks, which are centrally dispatched and on non-routine movements of men and materials.

The latest additions to the system are two-way, receiver-transmitter sets. One-way sets have the disadvantage of permitting receipt of messages only, with no opportunity for two-way communication.

The operating range of the radio system is about 20 miles, depending upon interference from structures which may be between sets. Shell has used the system to some extent for communicating with trucks off the refinery property, perhaps on the road to or located somewhere in nearby St. Louis.

No figures were given for the cost of the entire system. However, some idea as to the investment can be obtained from the price of the most recent order of six two-way radios, about $5,000 installed.

Operation of the system is licensed by the Federal Communication Commission. The refinery Automotive Department was responsible for the development of this system.

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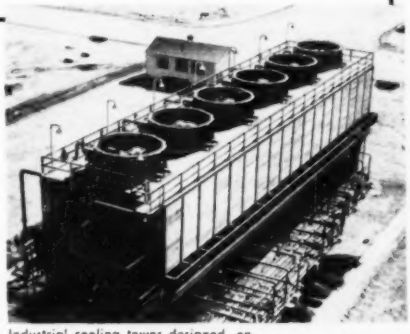
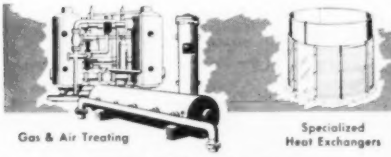


Industrial cooling tower designed, engineered and constructed by J. F. Pritchard & Co.

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**3.** Ionad 17 minimizes treatment of fuel oil stocks. In many cases the cost of adding Ionad 17 is *more than paid for* by savings in reduced fuel oil treatment alone.

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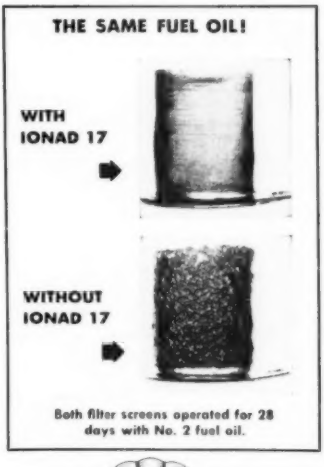

Both filter screens operated for 28 days with No. 2 fuel oil.

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**IONAD 17**

# C.F.R. Test Engine Calibrator Is Time Saver

By JAMES V. MARK
Socony-Vacuum Oil Co., Inc.,
Augusta, Kans.

SAFETY and speed in setting the volume clearance of a C.F.R. test engine can be attained with the simple device shown in the accompanying drawing.

Most engine operators have probably had the doubtful pleasure of adjusting the volume clearance of a cylinder by the old tilt method. In the Socony-Vacuum Oil Co. laboratory at Augusta, Kans., the time required for one man—with occasional assistance—to do this job properly by the old method was approximately one hour. By using the new calibration device, the time was reduced to approximately 15 minutes and can be performed by one man alone.

In C.F.R. engine operation, strict attention must be given to the smallest details in re-assembling an engine after an overhaul. Perhaps one of the most important of these details is the proper adjustment of the volume clearance of the cylinder, which in turn governs the compression ratio.

The old tilt method, used in the past, is outlined in Supplement III, Section 302 in the A.S.T.M. Manual of Engine Test Methods for Rating Fuels. To use this method, it was necessary to re-assemble the engine completely. Then the engine base cap screws at the end of the crankcase with the oil drain are removed and those at the other end are loosened. The engine then is tilted by blocking up the free end of the crankcase approximately ¾ in., thus making the bouncing pin hole the highest point of the combustion chamber. This tilting is done to prevent air from becoming trapped in the cylinder, which would give a false clearance volume adjustment.

With the engine tilted and the piston at top dead center, the correct volume of water is measured from a clean buret into the combustion chamber through the bouncing pin hole. The cylinder height is adjusted so that the water will just fill the combustion space to the top face of the bouncing pin hole. After the micrometer is adjusted properly, the water is removed and the engine placed back in its proper position.

To use the new volume clearance device, it is necessary to install the valves and spark plug in the cylinder and then place the cylinder in a suitable jig. Then the following operations are performed:

1—Lubricate the two top rings and the space between and above them on the piston with a water pump grease. Do not get any grease on top of the piston.

2—Insert the piston into the cylinder to within approximately 1½ in. of the top face of the bouncing pin hole.

3—Attach the volume clearance device to the bottom of the cylinder, and tilt the cylinder about 15° from the vertical so that the bouncing pin hole is the highest point of the combustion chamber.

4—Measure into the cylinder the correct volume of water.

5—By means of the volume clearance device, slowly and positively force the piston up into the cylinder until the bouncing pin hole is half full of water.

6—Now bring the cylinder back to a vertical position, being sure that water remains in the hole.

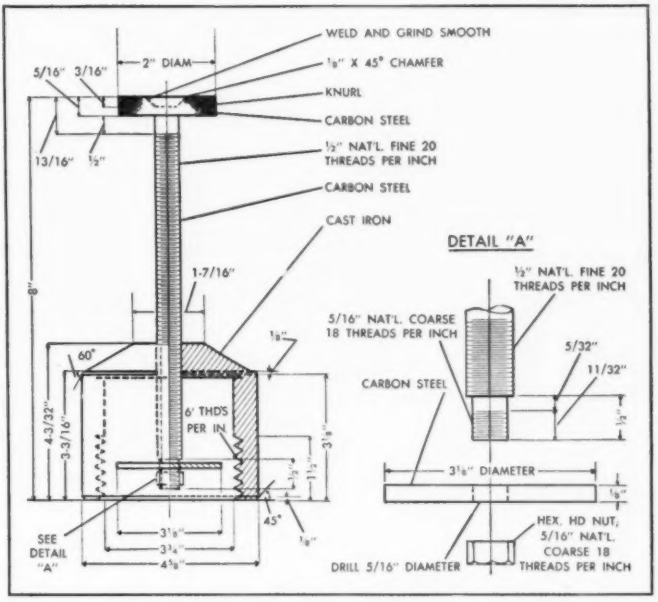
7—Place a straightedge across the top surface of the bouncing pin hole and force the piston up with device until the water just touches the straightedge.

8—After removing the water from the cylinder, measure accurately the distance between the top of the piston and the top face of the bouncing pin hole by means of a depth gauge of the micrometer type.

9—After the cylinder has been reassembled in the engine, place the piston at top dead center and adjust the cylinder height so that the depth gauge reading is the same as that obtained in the basic setting.

10—The micrometer is then properly adjusted, completing operation.

Since the volume clearance is adjusted with the cylinder on the bench, all danger of mashed fingers is eliminated because the crankcase did not have to be loosened from its base. From a safety standpoint, this is a fact worth careful consideration.




**CONSTRUCTION DETAILS** of volume clearance calibration device

# How to Control Poly Plant Recycle

By MILTON R. BEYCHOK*

THE optimum operation of a gas-feed polymerization unit requires that a portion of the exit gases be recycled for purposes of diluting the olefin content of the feed gases (see sketch). To determine and to control the amount of recycle gas in the feed, it is usual procedure to determine the olefin content of the gas streams. Un-

* Mr. Beychok is chief chemist, Rothschild Oil Co., Santa Fe Springs, Calif., and a previous contributor to these columns.

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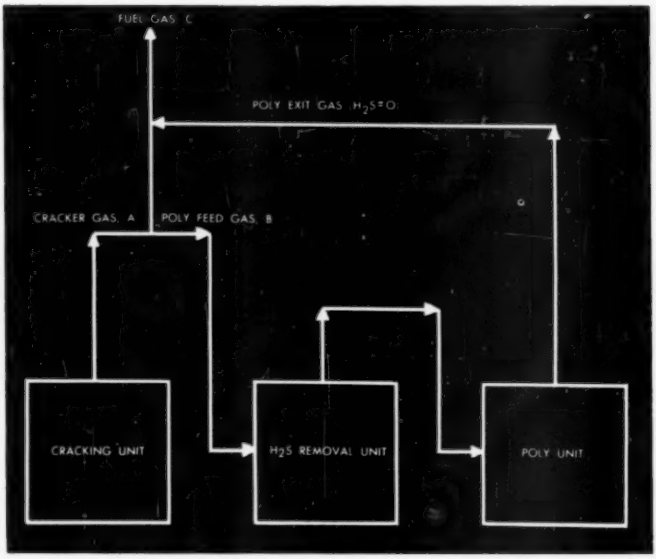


**SIMPLIFIED FLOW DIAGRAM** of method for controlling polymerization unit recycle for optimum operation

fortunately, such olefin analyses require tedious gas absorption procedures usually employing sulfuric acid as the absorption medium.

The Rothschild Oil Co. refinery at Santa Fe Springs, Calif., has found that the olefin determinations can be discarded in favor of a much simpler practice employing hydrogen sulfide determinations by the Tutwiler method.[1] The advantages of the $H_2S$ determinations of the olefin determinations are:

1. They are simpler to run and more rapid.

2. They can be easily run on-the-spot, which is difficult to do with an olefin gas determination apparatus.

3. The recycle stream need not be analyzed, since it most certainly can be assumed to have a zero $H_2S$ content. In contrast, this sample must be run if olefin contents are used for control.

4. The $H_2S$ content of the feed gas is useful information in its own right, for control of the $H_2S$ removal unit.

**How does the test work?** Referring to the diagram, if we have these data: $H_2S$ content of Gas $A$ = 2400 grains/100 cu. ft.; of Gas $B$ = 2000 grains/100 cu. ft.; and Gas $C$ = 0; then the Feed Gas $B$ contains [(2400 − 2000)/2400] × 100 = 16.7% of Poly Exit Gas as recycle.

If we have data such as: $A$ = 2400, $B$ = 2400, and $C$ = 0; then we are getting no recycle, and all the Poly Exit Gas is going to Fuel Gas.

If the data is: $A$ = 2400, $B$ = 2400, and $C$ = 200; then we are again not getting recycle, and some Cracking Plant Gas is being lost to Fuel Gas.

(1) "Gas Chemists' Handbook," 3rd Ed., p. 463, American Gas Association, New York, N. Y.

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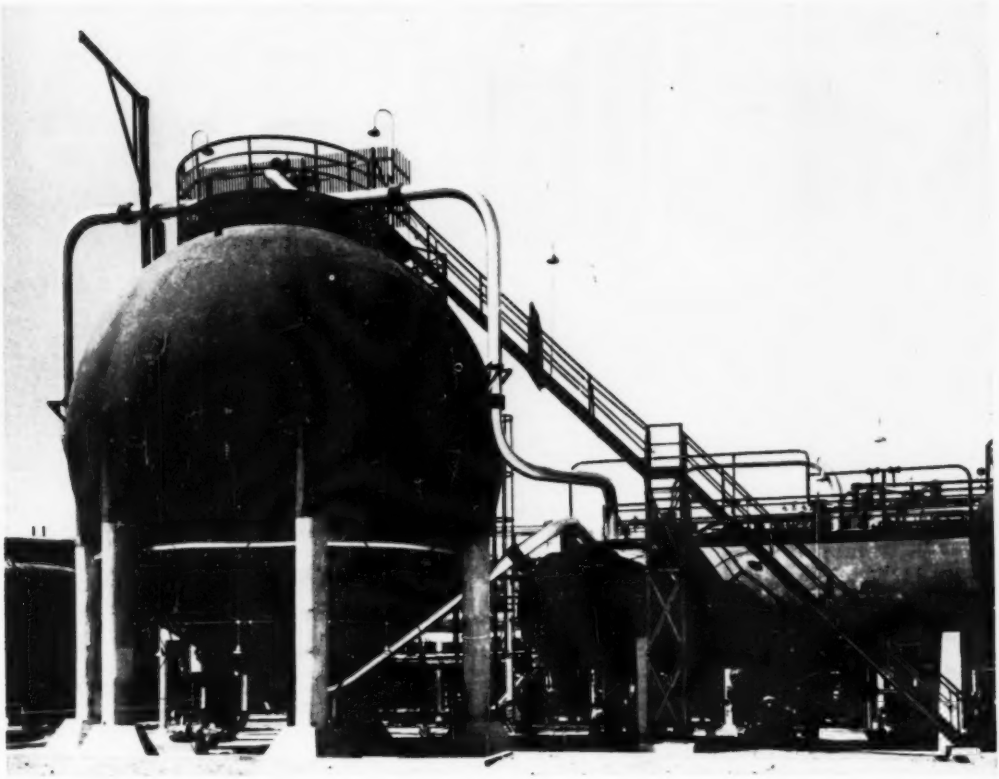

When the Pan American Refining Corporation made a thorough study of the effects of salts in the crude charge, their conclusions were that the charging of high-salt-content crudes resulted in low charging rates, short runs, excessive down-time, high repair costs, frequent equipment replacements and excessive strain, wear and tear on equipment. To prevent these difficulties a Petreco Electrosphere Desalter was installed.

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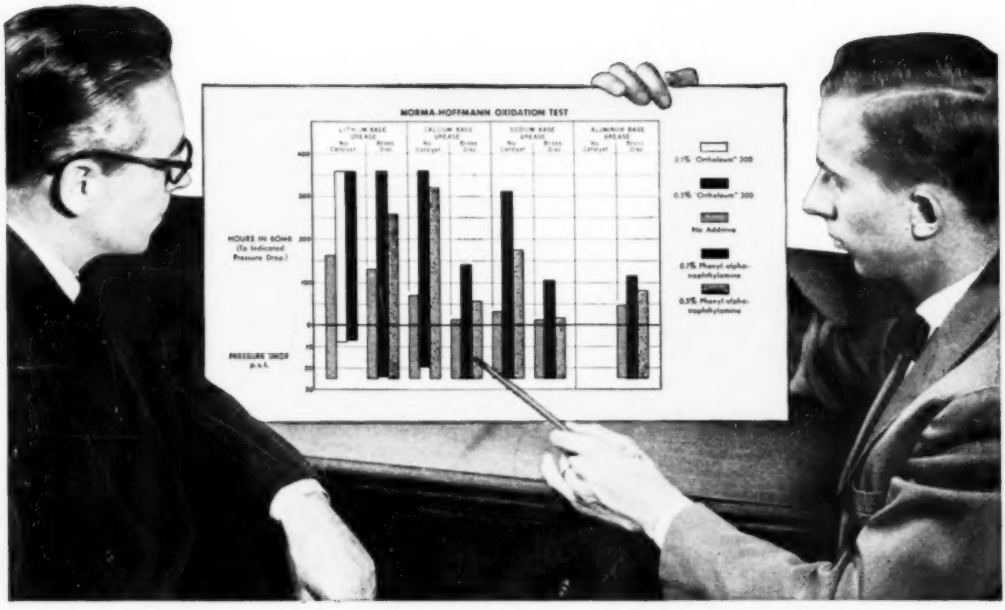


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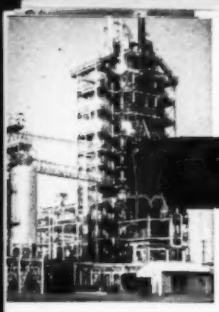
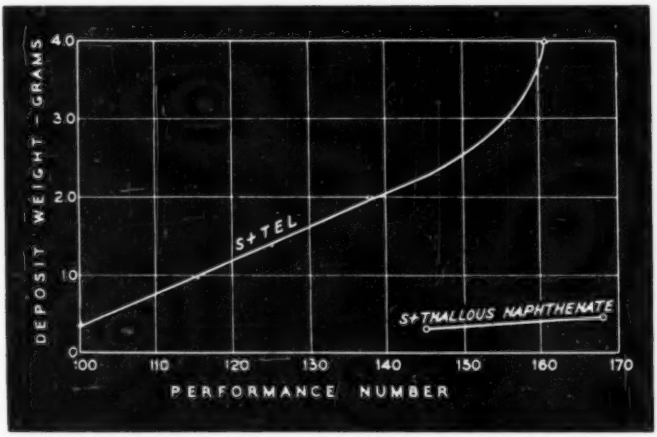


# PROCESSING PATENTS

**New Developments in Processes and Products**

By PETER J. GAYLOR, *Patent Attorney*
*Gaylor, Cifelli & Jurick, Newark, N. J.*

## *Thallium More Effective Than Lead In Improving Gasoline Performance*




**MARKED REDUCTION IN ENGINE DEPOSIT** is shown with thallium compound instead of tetraethyl lead for given performance number (U. S. 2,562,-885, California Research Corp.)

EVEN by combining the advantages of tetraethyl lead, superior base stocks, supercharging and rich mixtures, it is still difficult to meet certain aviation power requirements, such as are necessary in take-off of heavily loaded aircraft. It has been discovered, according to U. S. patent 2,562,885 issued to California Research Corp., that organo tallium compounds in which the thallium is in a mono-electrovalent state, improve the rich mixture antiknock ratings of spark ignition engine fuels. Although these compounds are especially effective for improving the rich mixture (F-4) ratings, they are also effective when added to base fuels having lean mixture (F-2) octane numbers as low as 85.

Thallous naphthenate is a viscous liquid having a pour point of 45° F. and contains 45.7% thallium. Data are presented showing that it takes considerably less thallium than lead to effect the same increase in performance number of a given fuel. It has been found that each incremental amount of mono-electrovalent thallium is about 4-10 times as effective as the lead in tetraethyl lead, using S-reference fuel of 100 performance number as the base fuel. The preferred concentration is 0.00085-0.013 wt. % of thallium in the fuel, in the form of oleate, cetyl phenate, heptadecylate, naphthenate, etc.

One of the main advantages noted for the thallium additive is that cylinder deposits in spark ignition engines are considerably lower than when lead tetraethyl is employed. As can be seen in the chart above, the amount of deposit is considerably less than with leaded fuel.

## *Adding Phenols Promotes Removal of Mercaptans*

OXIDATION of mercaptans by air or oxygen in presence of alkalis can be accelerated by adding small amounts of certain phenols, as is shown in the Pevere patent 2,-015,038. Certain of these phenols are more effective than others. Dihydroxy aromatic compounds having the hydroxyl groups in ortho or para position are particularly potent in this respect. Examples of such materials are 4-tert. butyl catechol, 4-cyclohexyl catechol, and 1, 2, 4-trihydroxy benzene.

The phenolic material is added to the caustic solution in amount of 0.1-5% by weight. To avoid contamination of the naphtha with the disulfides formed, the mercaptans are first extracted with the caustic and the latter is then blown with air or oxygen at 80-130° F. Solutizer materials may be added to the caustic (U. S. 2,550,905—Standard Oil Co. Ind.)

## *Treating with Aldehydes Improves Product Quality*

AN interesting process development in the treating field worthy of note is described in a series of patents (U. S. 2,567,173-4-5) issued recently and assigned to Standard Oil Development Co.

When a cracked stock is treated with strong sulfuric acid for removal of mercaptans and other sulfur compounds, as well as olefinic constituents, excessive polymerization takes place with loss of some gasoline to higher polymers. And, when a large amount of acid is used, it is necessary to subsequently sweeten the gasoline by the usual "doctor treat".

The new process involves adding an aldehyde (1.5-3%), such as paraldehyde, to the sour, cracked gasoline, and then effecting a condensation of the aldehyde with the sulfur compounds and diolefins by addition of 0.5-20 vol. % of sulfuric acid of 30-80% concentration.

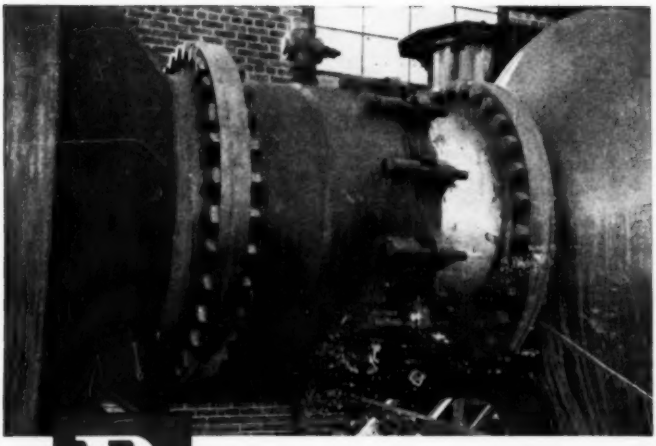
In one example, a thermally cracked hydrocarbon fraction boiling at 60°-400° F. was treated at 70° F. with 60% sulfuric acid containing 5% by weight of formaldehyde based on the gasoline fed. The volume of acid used per volume of oil was 20%. The acid layer was separated from the oil layer, and the latter was water-washed, caustic-washed and then steam distilled. Results of the treatment are given in Table 1.

It will be observed that the diolefin content was reduced to one-half, the copper dish gum and peroxides to a very small value, the total sulfur to about one-third the original value.

**Table 1—Treating Cracked Stock with Acid and Aldehyde**

| | Untreated Fraction | Treated Fraction |
|---|---|---|
| Diolefin content, % | 2.95 | 1.46 |
| Copper dish gum, mg./100 cc. | 196 | 5 |
| ASTM breakdown(1) | 185 | 1.440 |
| Peroxide no.(2) | 1.1 | 0.2 |
| Total sulfur, % | 0.137 | 0.046 |

(1) ASTM designation D 525-46.
(2) Milliequivalents of peroxide $O_2$ per liter.



Rx for steel mill gas pains

ADSCO Expansion Joints

Just What the Doctor Ordered

In most coke oven gas mains, expansion is absorbed by a series of unwieldy disc diaphragms fabricated directly into the lines. However, these installations often prove unsatisfactory because of limited contraction, ruptures, shutdowns for repair, etc.

Last year, after detailed study, a large steel mill in the East selected ADSCO Piston-Ring Expansion Joints. Eight 36" and five 24" slip-type joints, with 8" traverse and special piston rings, were installed in lines carrying coke oven gas at 200 F. and 25 psi.

This installation proved so successful and so satisfactory in service that more ADSCO Piston-Ring Expansion Joints are now on order for similar applications.

For 75 years, ADSCO has prescribed the *best* remedy for *every* pipe-line expansion problem. ADSCO made the first expansion joint . . . ADSCO now makes the most complete line of expansion joints available from any manufacturer. When *your* problem is pipe-line expansion, why not profit by the experience of hundreds of other companies? Consult ADSCO.

ADSCO Piston-Ring Expansion Joints can be packed under full line pressure. They are made in a complete range of sizes for pressures to 400 psi or greater and temperatures to 750 F. or higher. For further information, write for Bulletin No. P-35-15.

In addition to more than 6500 standard models of slip-type joints, ADSCO makes complete lines of *Corruflex* Packless Corrugated Expansion Joints and Variator diaphragm-type Expansion Joints.

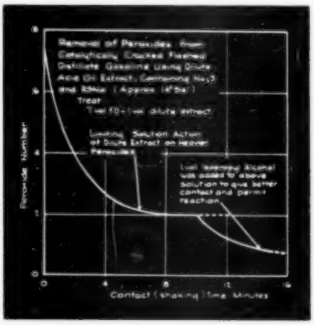
AMERICAN DISTRICT STEAM COMPANY, INC. • North Tonawanda, N. Y.

## Processing Patents

Engine tests showed excellent removal of sludge and varnish-forming ingredients.

Use of formaldehyde in treating another sample showed a reduction in diazonium fluoborate deposit factor (which is used as an indication of engine cleanliness characteristics of cracked gasolines). In this case, the gasoline and formaldehyde only were heated to 100°-400° C. to effect the treatment.

Virgin naphtha also was treated with formaldehyde and acid, reducing copper number from 48 to 0 and giving a doctor sweet product. Neither 88% sulfuric acid nor formalin alone were able to effect sweetening to such an extent.


Removal of Peroxides from Catalytically Cracked Finished Distillate Gasoline using Dilute Acid Oil Extract, Containing NaOH and Alkali (Approx. 6° Be')
Treat
Test 10-ml. dilute extract
Shaking Reaction Action of Dilute Extract on Neutral Peroxide
Test isopropyl Alcohol was added to above solution to give better contact and permit reaction
Peroxide Number
Contact (shaking) Time, Minutes

**REMOVING PEROXIDES** with sodium sulfide (U. S. 2,545,199, Shell Development Co.)

## Sodium Sulfide Removes Peroxides from Gasoline

ACCORDING to a recent patent issued to Shell Development Co. (U.S. 2,545,199), peroxides present in gasoline may be removed by contacting it with an aqueous alkali solution containing about 1-15% of added sodium sulfide which reduces the peroxide. As can be seen above, acid oil extract containing sodium sulfide was able to reduce the peroxide number from about 7.5 to 2.0. Addition of some isopropyl alcohol caused a further reduction to below 1.0, due to the solubilizing effect on higher or heavier peroxides.

## More on Peroxide Removal

APPARENTLY a considerable amount of oil deterioration in storage is due to oxidation, polymerization and other reactions resulting in formation of gum and peroxides. These peroxides hasten considerably further deterioration of the oil. A patent (U. S. 2,526,499) issued to Standard Oil Development Co. discloses that peroxides can be completely removed from higher boiling

petroleum fractions by contacting them with a bleaching earth such as Attapulgus clay at 60-120° F., preferably 70-90° F.

Some data submitted showed that a gasoline having a peroxide number of 2.7, when filtered through 30/60 No. 1 Attapulgus clay at 75° F. had zero peroxide number.

## Patents Issued in October

*The following classified listing gives the patent number, patentee or assignee, and a brief description of all patents believed to be of interest to the petroleum processing industries, as contained in the Official Gazettes of the U. S. Patent Office for October 2, 9, 16, 23, and 30, Vol. 651, Nos. 1-5.*

### Refining

2,569,463 (The Texas Co.) Treatment of naphtha containing oxygenated compounds.
2,569,984 & 6 (Shell Development Co.) Extractive crystallization process.
2,570,044 (Phillips Petroleum Co.) Propane fractionation of reduced crude oil with recycle of a solvent extract.
2,570,066 (Standard Oil Development Co.) Extractive distillation process.
2,570,205 (Standard Oil Development Co.) Extractive distillation of alcohols with sulfolane.
2,570,277 (Standard Oil Development Co.) Sweetening process with strong and weaker caustic.
2,570,278 (Standard Oil Development Co.) Sweetening process using alkali metal hydroxide containing high-boiling mercaptan salts.
2,570,607 (Sinclair Refining Co.) Vacuum distillation of reduced crude.
2,570,611 (Monsanto Chemical Co.) Process for breaking petroleum emulsions.
2,570,974 (Phillips Petroleum Co.) Dehydration of petroleum hydrocarbons.
2,571,107 (L. Sonneborn Sons, Inc.) Recovery of acid values from sulfuric acid sludges.
2,571,116 & 9 (Petrolite Corp. Ltd.) Processes for breaking petroleum emulsions.
2,571,329 (Union Oil Co.) Adsorption process.
2,571,380 (Socony-Vacuum Oil Co.) Method of regenerating adsorptive material.
2,571,606 (Pure Oil Co.) Sweetening by oxidation of mercaptans with air, alkali and a quinone.
2,571,752 (The Texas Co.) Separation of oil from wax.
2,571,936 (Standard Oil Development Co.) Sorption of hydrocarbons by activated carbon.
2,572,223 (Socony-Vacuum Oil Co.) Separation of petroleum-in-water emulsions.
2,572,301 (Socony-Vacuum Oil Co.) Prevention of corrosion in process of extracting mercaptans.
2,572,433 (Socony-Vacuum Oil Co.) Continuous contact filtration.
2,572,519 (Standard Oil Development Co.) Sweetening process using weak and then strong caustic.
2,572,583 (Phillips Petroleum Co.) Improved liquid-liquid contacting process using dibeta-cyanoethyl amine.
2,572,595 (Phillips Petroleum Co.) Dehydrofluorination process.
2,572,866 (Standard Oil Development Co.) Method of improving lubricating oil by adsorption on silica gel.

### Conversions

2,569,846 (Gulf Oil Corp.) Method of starting a unit for high-temperature reactions.
2,570,032 (Standard Oil Development Co.) Method for preparing an olefin polymerization feed stock.
2,570,067 (Phillips Petroleum Co.) Hydrocarbon conversion with vanadia- and/or molybdena-containing catalysts.
2,571,262 (Phillips Petroleum Co.) Method of hydrocarbon conversion utilizing Friedel-Crafts catalysts.
2,571,342 (Socony-Vacuum Oil Co.) Combination hydrocarbon vaporization and cracking process.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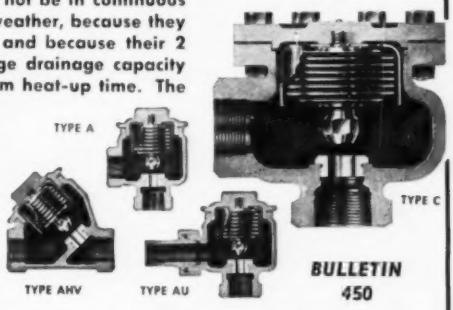
**Freeze-Proof Steam Traps**

for Every Plant Use

**Because they drain completely when cold, these four types of Nicholson steam traps are positively freeze-proof. Can be freely installed outdoors. Universally recommended for use in lines which need not be in continuous use during cold weather, because they are freeze-proof and because their 2 to 6 times average drainage capacity results in minimum heat-up time. The non-air-binding feature of Nicholson traps also notably facilitates heat transfer in severe weather. Sizes ¼" to 2"; pressures to 225 lbs.**




**BULLETIN 450**

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***Invaluable for sampling liquids and gases***

At last here are the Hoke Pressure Sample Containers standard pressure vessels made of stainless steel to the most rigid specifications.

This new Hoke product is proving invaluable for sampling of both liquids and gases. They are ICC approved and available in two standard service pressure ranges, namely: 400 psi and 1800 psi. Either double or single valving is obtainable. 18-8 Stainless Steel is standard material. Other metals, ferrous or non-ferrous, manufactured on special order.

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**Hoke Incorporated**

ENGLEWOOD, N. J.

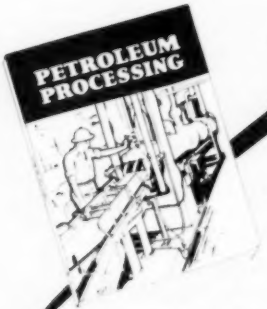



*(To obtain more data on advertised products see page 1428)*

*Make a Sound Decision*

TO INCLUDE THIS LOGICAL EQUIPMENT IN YOUR 1952 EXPANSION PLANS

# WELDING ENGINEERS REVOLUTIONARY *CONTINUOUS* WAX CRYSTALLIZER*




This is TOP-NEWS with petroleum executives responsible for the modernization and expansion of major plants . . . for it enables them to bypass the costly, time-consuming hand method of slabbing wax cakes which until now was accepted as one of the "necessary evils" of the industry.

WELDING ENGINEERS climaxes two years of extensive effort with the development of this LOGICAL one-operation wax slabbing machine incorporating dual counter rotating screws. You know all the facts about this proven producer of ready-to-package slabs direct from a molten state . . . *without interruption* and with only a single attendant for as many as three machines.

All types of paraffin and microcrystalline waxes can be handled, especially 'trouble' waxes with high melting points . . . and difficult, sticky, tacky, non-moldable blends. Top production rates are conservatively set at 22 tons every 24-hour period per unit

*Patents Pending

We will be pleased to furnish reprints of Petroleum Processing's unbiased study of "molding wax cakes by extrusion" as featured in the September 1951 issue. Step by step, it takes you along the entire logical process . . . as seen through the experienced eye of the editor . . . presented to the engineering reader as the vanguard of progress in the production of an important . . . *and now more profitable* . . . refinery by-product . . . *petroleum wax slabs!*

MACHINERY DIVISION
**WELDING ENGINEERS, INC.**
NORRISTOWN, PA.

*We will be pleased to work with your designing engineers in the application of this wax crystallizer equipment in your present or expanded plant.*

## Processing Patents

2,572,019 (E. I. Du Pont de Nemours & Co.) Catalytic process for alkylating aromatic compounds using a metal molybdite catalyst.
2,572,338 (Universal Oil Products Co.) Autothermic cracking reactor.
2,572,724 (Shell Development Co.) Propylene tetramer production.
2,573,149 (Universal Oil Products Co.) Three-stage catalytic process for the reforming of gasoline.

### Hydrocarbon Synthesis

2,570,615 (Universal Oil Products Co.) Method of removing carbon monoxide from hydrocarbons.
2,571,151 (M. W. Kellogg Co.) Separation of organic compounds.
2,572,061 (Texaco Development Corp.) Process for the hydrogenation of coal.
2,572,633 (Phillips Petroleum Co.) Prevention of solid deposits in Fischer-Tropsch plant lines.
2,573,185 (Phillips Petroleum Co.) Separation of oxygen-containing compounds.
2,573,559 (Phillips Petroleum Co.) Method for replacing deactivated hydrocarbon synthesis catalyst with fresh catalyst.

### Catalysts

2,570,058 (Standard Oil Development Co.) Preparation of magnesia gels.
2,570,063 (Standard Oil Development Co.) Treatment of microspherical particles to render them nonagglomerating.
2,572,321 (Universal Oil Products Co.) Preparation of fine powders from gel materials.

### Chemicals

2,569,440 (The Texas Co.) Separation of isophthalic acid from terephthalic acid by noncatalytic esterification.
2,569,671 (Cities Service Oil Co.) Purification of crude alcohols.
2,569,985 (Shell Development Co.) Thioureaketone complexes.
2,570,037 (Standard Oil Development Co.) Esters of aliphatic dibasic acids and ether-alcohols containing a branched chain in the glycol group.
2,570,038 (Standard Oil Development Co.) Phenylenediacetate ester.
2,570,059 (Standard Oil Development Co.) Condensation products of tertiary alkyl mercaptans and alkylene oxides.
2,570,074 (Standard Oil Development Co.) Dry ice manufacture.
2,570,083 (Standard Oil Development Co.) Production of thiophene from diolefin and hydrogen sulfide.
2,569,492 (M. W. Kellogg Co.) Production of organo-tin compounds.
2,570,215 (Celanese Corp. of America) Production of formaldehyde from oxidation of butane.
2,570,216 (Celanese Corp. of America) Treatment of hydrocarbon oxidation products.
2,570,217 (Celanese Corp. of America) Concentration process for hydrocarbon oxidation products.
2,570,403 (Gulf Research & Development Co.) Stabilization of phenol alkylates by amines.
2,570,407 (Phillips Petroleum Co.) Reactions involving the use of hydrogen halides.
2,570,512 (Universal Oil Products Co.) Manufacture of dialkyl hydrogen phosphites.
2,570,512 (Universal Oil Products Co.) Modified phenolic resins.
2,570,542 (Universal Oil Products Co.) Phosphoric acid catalyzed thiophene alkylation and gravity separation of resultant products.
2,570,574 (Universal Oil Products Co.) Production of 2,3-dimethylalkanes.
2,570,601 (Universal Oil Products Co.) Production of resins from butadiene monoxide and from mixtures of butadiene monoxide and vinyl compounds.
2,570,686 (Metal & Church) Process for making tin hydrocarbons.
2,570,722 (The Texas Co.) Production of thiophene compounds from a sulfur dioxide and hydrogen sulfide mixture.
2,571,114 (Phillips Petroleum Co.) Di(tert-alkyl) mercaptals.
2,571,157 (Sharples Chemicals, Inc.) Manufacture of high molecular weight thioethers.
2,571,160 (Standard Oil Development Co.) Oxo synthesis process.
2,571,217 (Shell Development Co.) Production of halohydrin ethers of phenols.
2,571,370-1 (Socony-Vacuum Oil Co.) Preparation of 2,2'-dithienyl disulfide.
2,571,737 (Pure Oil Co.) Method of sulfurizing terpene hydrocarbons.
2,571,919 (Standard Oil Development Co.) Process for concentrating aqueous acid solutions utilizing combinations of low and high boiling solvents.


**Versatile Top Entering Mixer by Eastern**

Versatile! Series C Vertical Mixers do big mixing jobs quickly and thoroughly. Their power range is from ¼ to 15 H.P. at standard speeds of 1725, 1140, 420, and 280 R.P.M. Standard NEMA ball-bearing type motor is furnished. Stuffing box is separate component and can be specified in any alloy for low original cost. Write our engineers about your mixing problem. Their service is without obligation.

*Send now for new Eastern Mixer Catalog No. 600*

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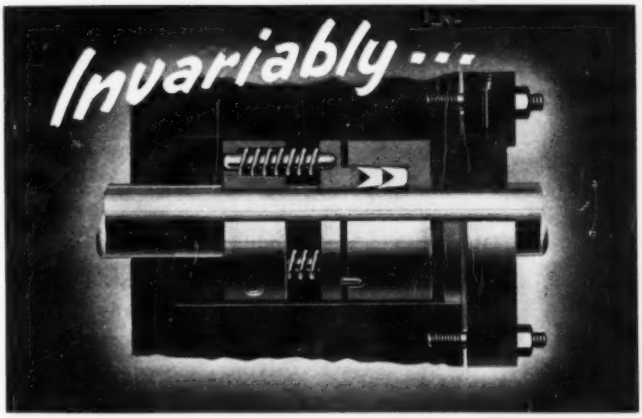


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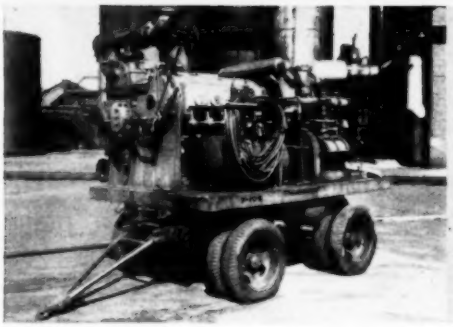

A portable R-C Inert Gas Generator used for purging operations and stand-by protection in large gas-producing plant. Capacity 15,000 cfh.

Today's urgent production demands can tolerate no unwarranted risk of interruption by explosions which might cause even small fires or other plant damage. Against such hazards, R-C Inert Gas Generators provide positive, economical protection.

This protection is essential in plants where inflammable gases, liquids, explosive dusts and other dangerous materials are handled, processed or stored. Available either in stationary or mobile units, R-C Inert Gas Generators greatly reduce the risks from fires caused by explosions. They are compact, simple and sturdy in construction and operate at extremely low cost. Available in capacities from 1,000 to 35,000 cfh.

If your operations involve materials or processes which might cause explosion-produced fires, investigate the protection afforded by R-C Inert Gas Generators. Installation costs in many cases can be offset by insurance savings. Ask us for details.

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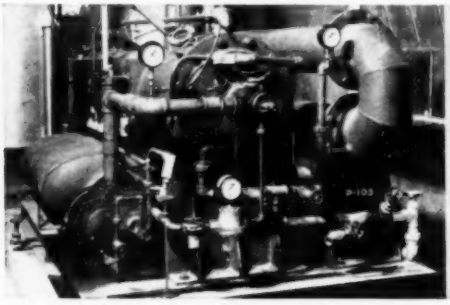
510 Texas Avenue, Connersville, Indiana



Installation of three R-C Inert Gas Generators similar to this one helped one large plant save $6,000 per month insurance premiums, as well as substantially reduce danger of production losses caused by explosion or fires. Capacity of each unit, 6,000 cfh.

ROOTS-CONNERSVILLE
BLOWER BUILDERS SINCE 1854
ONE OF THE DRESSER INDUSTRIES


## Processing Patents

2,571,928 (Standard Oil Development Co.) Resinous compositions comprising a styrene isoolefin copolymer and a vinyl polymer.
2,572,238 (Shell Development Co.) Carboxylic acids from mercaptans.
2,572,251 (Shell Development Co.) Hydrolysis of hydrocarbon halides.
2,572,664 (Phillips Petroleum Co.) Manufacture of acetylene.
2,572,701 (Koppers Co., Inc.) Preparation of cumene.
2,572,955 (Standard Oil Development Co.) Packaging tacky isobutylene-diolefin rubber in film of compatible styrene-isobutylene copolymer.
2,573,341 (Lummus Co.) Production of ethylene.

### Fuels

2,570,377 (Tide Water Associated Oil Co.) Fuel compositions containing phenolic amines.
2,570,999 (United States of America) Fuel compositions and their preparation.
2,571,987 (Ethyl Corp.) Conversion of hexaalkyldilead to tetraalkyllead.
2,572,829 (Phillips Petroleum Co.) Coal gasification process and apparatus.
2,572,887 (Stanton) Solid-liquid reaction processes for organo metallic compounds.
2,572,579 (Shell Development Co.) Leaded fuel composition containing compound with two halogens.

### Lubricants

2,570,402 (Gulf Research & Development Co.) Antioxidants for oils and oil compositions containing the same.
2,570,719 (Standard Oil Development Co.) Foam suppressed lubricant compositions.
2,570,788 (Socony-Vacuum Oil Co.) Synthetic lubricants.
2,570,846 (Socony-Vacuum Oil Co.) Mineral oil compositions containing esters of reaction product of maleic anhydride and styrene.
2,571,332 (Socony-Vacuum Oil Co.) Thiophenethiolphosphorus halide reaction products in lubricating compositions.
2,571,333 (Socony-Vacuum Oil Co.) Thiophenethiols-phosphorus halide reaction products. ethiolphosphorus halide reaction products.
2,572,000 (Standard Oil Co., Ohio) Antisludge additives for hydrocarbon oils.
2,572,429 (American Cyanamid Co.) Aluminum soap composition.
2,573,294 (Phillips Petroleum Co.) Method of stabilizing hydrocarbons with phenolic salts.
2,572,568 (Shell Development Co.) Lubricant compositions containing di-alkyl thihaloalkane phosphonate as an extreme pressure agent.
2,573,650 (Shell Development Co.) Water-resistant greases.
2,572,558 (Monsanto Chemical Co.) Mineral oil containing alkylated polystyrene.

### Specialties

2,569,595 (Pan-American Refining Corp.) Preparation of drying oils from clay polymers.
2,569,695 (Socony-Vacuum Oil Co.) Crush proofing and waterproofing.
2,570,051 (Standard Oil Development Co.) Insecticidal compositions containing beta-(tertiary-alkyl thio) alkanols.
2,570,023 (Standard Oil Development Co.) Parasiticidal steam-cracked oil emulsion concentrate.
2,570,185 (Minnesota Mining & Manufacturing Co.) Alkoxysilaneamine asphalt additive.
2,570,892 (Sun Oil Co.) Sealing agents.
2,571,856 (Standard Oil Development Co.) Cleaning composition for removing asphaltic coatings.
2,572,734 (Phillips Petroleum Co.) Production of carbon black from high-boiling aromatic oils or tars.
2,573,422-3 (Sun Chemical Corp.) Wax composition and preparation thereof.

### Miscellaneous

2,569,510 (The Texas Co.) Electrical analogues.
2,570,064 (Standard Oil Development Co.) Method for determining cut point in pipe-line crude oil batching.
2,570,487 (Shell Development Co.) Temperature control during exothermic reactions.
2,570,543 (Pittsburgh Consolidation Coal Co.) Conversion of carbon to electrical energy.
2,571,470 (Shell Development Co.) Continuous determination of fluid mixture compositions.
2,571,739 (Pure Oil Co.) Prevention of corrosion of structural metals by hydrogen sulfide, air and water.
2,571,839 (Socony-Vacuum Oil Co.) Index for sensitive measuring instruments.

DU PONT
REG. U. S. PAT. OFF.

PETROLEUM CHEMICALS DIVISION
# NEWS

DU PONT
REG. U. S. PAT. OFF.

December ★ One of a Series of Interest to the Petroleum Industry ★ 1951

*Season's Greetings*

to the

**PETROLEUM INDUSTRY**

**PETROLEUM CHEMICALS DIVISION**

## Special Du Pont Paper Helps Seismic Prospectors Get Better Records

Oil prospectors want seismograph charts that point up the facts clearly and quickly . . . charts that are always easy to read and interpret.

Du Pont Seismograph Paper is specially made to help prospecting crews get better charts. It is a fast, high contrast recording paper with exceptionally wide latitude to permit rapid, easy processing at high temperatures, without loss of quality. And it is made to stand up under the tough, widely varying field conditions met by seismograph crews.

The paper is available in 50 to 200 foot rolls, in a wide range of widths.

## Petroleum Chemicals District Office Managers Coordinate Many Du Pont Services to Help Refiners

BOTH BY nature and necessity, the typical Du Pont Petroleum Chemicals Division District Office Manager is a versatile individual.

He is required to know the answers to many questions. His desk is a limitless well of useful information for petroleum refiners and marketers. While very few oil men know him personally, he is always alert to their problems, always ready to coordinate the facilities of the Du Pont Company into helpful services for the Petroleum Industry.

WALTER MANSBERGER, office manager of the Gulf Coast District, handles many requests for service to refiners every day. He is one of the five Du Pont Petroleum Chemicals Division district office managers engaged in this work.

In much the same way as a control tower operator keeps traffic flowing smoothly at a busy airport, the District Office Manager coordinates the field work of Du Pont sales-service representatives. He knows where each man is working every day. And he is able to channel requests for technical assistance to the right man immediately . . . and switch men *en route* if the situation requires.

A comprehensive understanding of refinery problems is part of his job. To enable a representative to be most helpful at a tank cleaning, for example, the office manager must first get all the facts concerning the job . . . such information as tank size, repairs needed, and whether it is necessary to have the tank declared "lead-free."

**THE "ANSWER MAN"!** Answering questions on Du Pont products is sometimes like conducting an "Information Please" program—with the office manager as the genial MC. The questions concern everything from tank car deliveries to technical data of the most elaborate sort.

Although not necessarily an engineer or chemist, the office manager can always find the answer to the most technical question – by contacting the Du Pont Petroleum Laboratory, a district laboratory, the Chambers Works, or any of the many other Du Pont sources. He can also arrange to have a Du Pont specialist come to your plant to discuss specific problems. And in addition to petroleum chemicals, he frequently handles and properly channels requests for information on neoprene, explosives for seismic explorations, and many other Du Pont products used in the petroleum industry.

OVER

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

PETROLEUM CHEMICALS DIVISION
# NEWS

CONTINUED *Office Manager*

**MARKETING AIDS, TOO!** Suppose a refiner desires to put on a dealer training meeting, or a demonstration for large fleet customers. Again, the Du Pont District Office Manager can be of help.

He will furnish an entertaining movie—booklets on gasoline quality—speakers and other promotion aids . . . with a highly instrumented Du Pont Test Fleet car, too, if that seems desirable. One of his "side lines" is helping to set up displays and demonstrations for schools and civic groups.

Everyone has heard that old adage, "When you want to get something done, ask a busy man." The next time Du Pont can be of service to *you*, just remember that the Petroleum Chemicals District Office Manager is *your* "busy man."

## "The Customer Votes Every Day" Public Relations Man Stresses

HAROLD BRAYMAN, Director of Du Pont public relations, speaking at the Atlantic City NPA meeting, said: "By purchasing products or services of his own selection, the customer votes on business every day.

"These votes make big business big—yet the public constantly falls prey to the idea that bigness should be destroyed."

How can business overcome this malicious political idea?

"Most successful sales and promotional campaigns," Mr. Brayman continued, "are based on personal contact. Therefore, if business is going to win public understanding, it must take its fight right down to the small circle of contact surrounding a company's employees, stockholders, customers, neighbors and friends.

"If each company would make a real effort to tell the facts to those within sound of its own voice, I think we would be well on our way to better understanding.

"Once understanding is gained in each of these small circles of influence, the over-all effect will be such that business need fear no attack . . . because political groups are as sensitive to public opinion as business is to market votes," Mr. Brayman concluded.

## Display Made For Oil Progress Week Available to Refiners For Showings

Five identical displays made for use by Du Pont Petroleum Chemicals Division district offices during Oil Progress Week are available to oil companies for special occasions.

The displays point out to the general public that petroleum is the source of many Du Pont products. These products in turn are fabricated by other manufacturers into consumer goods that benefit millions of people.

Each of the displays is made up of three panels. When assembled as a unit the display is 10 feet long and 5 feet high. It can be set up on legs to stand on the floor, or be shown without legs for window use.

The two side panels are demountable, as are the four product panels on each of them. This provides a flexibility that permits the display to be used in either large or small spaces.

Overhead lights are provided with the display and complete instructions for setting it up are included. Two men can erect the piece in eight minutes.

The nearest Du Pont Petroleum Chemicals Division district office will make the display available to oil companies on request.

## "Pipeline on Wheels" A Public Relations Hit

Since the first public showing of "Pipeline on Wheels" at the Atlantic City NPA meeting in September, more than 100 prints of this new Du Pont color movie have been put into circulation.

The picture is designed to help oil companies prove to public officials, civic organizations and motorists that tank trucks for transporting gasoline are not the dangerous highway safety hazard which some people consider them to be . . . and that they are important to modern, motorized civilization.

The great number of requests for prints indicates an enthusiastic acceptance among oil men. Prints are loaned or sold to oil companies interested in using the film in their own training or public relations programs.

DU PONT
Better Things for Better Living . . . through Chemistry

# Petroleum Chemicals

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Petroleum Chemicals Division • Wilmington 98, Delaware

*District Offices:* New York, N. Y. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · Los Angeles, Calif.

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IN CANADA: Canadian Industries Limited — Toronto, Ontario — Montreal, Quebec

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A-2699

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# NEWS OF SUPPLIERS

**Manufacturers**
**Distributors**
**Engineering Firms**

### Du Pont Promotes Three

Effective January 1, R. M. Glover of DuPont's Wilmington sales office will become manager of the Mid-Continent district of the Petroleum Chemicals Division, at Tulsa, Okla. Charles D. Towery, present manager at Tulsa, will take over as manager of the division's Gulf Coast district in Houston. Alfred R. Mullis, district manager at Houston, has been named manager of the Eastern District with offices in New York City.

Mr. Glover

Mr. Towery

Mr. Mullis

Mr. Glover attended Rice Institute, being graduated in 1938. Prior to joining DuPont, he was associated with Humble Oil & Refining Co., of Baytown, Texas. During the war years he served as a petroleum inspector in the U. S. Navy.

Mr. Towery, a graduate of Texas A. & M., was with the Bethlehem Supply Co. of Houston, prior to joining the DuPont Co. in 1947 as a salesman of petroleum chemicals.

Mr. Mullis has been a service representative in the Gulf Coast District since 1947 and has been manager since June, 1950. A graduate of Rice Institute, he was formerly employed in the Research and Development department, Humble Oil & Refining Co.

### Warner Lewis Expands Facilities

Construction has begun on added facilities for the Warner Lewis Co., across the street from their present location at 817 Lewis Place, Tulsa, Okla. When completed, they will have almost 20,000 sq. ft. of shop space for fabrication. The extra shop space and new fabrication equipment will enable Warner Lewis to handle all types of non-ferrous and special alloy fabrication—pressure vessels, mixers, kettles, piping, tanks and small towers.

### New Firm Offers Design Service

Mechanical Design, Inc., a new firm which began operations November 1st, will specialize in refinery and gasoline plant design. Offices are located at 517 Wright Bldg., Tulsa.

Officers of the new company are: J. R. Lawrence, president; Herbert E. Dyer, vice president and manager; Maloy Stevenson, secretary; and Huff D. Peters, treasurer.

### Foote Buys Lithium Plant

In a $350,000 purchase, Foote Mineral Co. exercised its option to buy the plant and holdings of Solvay Process Division of Allied Chemical and Dye Corp. at Kings Mountain, N. C., including land already owned by Foote. It gives the company control of the largest source of lithium bearing ores in the western hemisphere.

Foote is licensee for the Earle patents covering production of lithium greases in the domestic and foreign markets. There are currently 27 major U. S. oil companies licensed to produce multi-purpose lithium greases.

### Refinery Engineering Adds Oil Vet

Harold F. Koons, identified with the oil industry for the past ten years, has joined the Refinery Engineering Co. of Tulsa, Okla. as project engineer. He spent several years with Jones & Laughlin Supply Co., Tulsa, in their engineering and construction division as a process and mechanical engineer. Mr. Koons was more recently employed as a refinery engineer with the Derby Oil Co., Wichita.

### Elects New President

Raymond E. Olson was elected president of the Taylor Instruments Companies at the annual stockholders meeting in Rochester, N. Y. on November 21st. He succeeds Lewis B. Swift, who was named chairman of the Board.

Mr. Olson

Mr. Olson joined the company in 1917. He became manager of the Application Engineering Department in 1927, and rose steadily to the vice presidency in 1946. He now becomes the seventh president of the organization.

All other officers were reelected to office as well as to directors of the

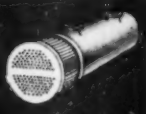
## Filtrol Addition to Accommodate Research Needs

**New 16,000 sq. ft. research building** which Filtrol Corp., producer of petroleum cracking catalysts, adsorbents and related products, will construct to house its varied and greatly expanding research activities. The research building, with individual laboratories and offices to be separated by fire-proof walls of metal stud and plaster construction, is being built by the general contracting firm of McIsaac Menke & Roach of Los Angeles, and will be located adjacent to Filtrol's Vernon manufacturing facilities. Completion is expected before the middle of 1952.

ALCOA

ALUMINUM

Alcoa Heat Exchanger News



Published by Aluminum Company of America

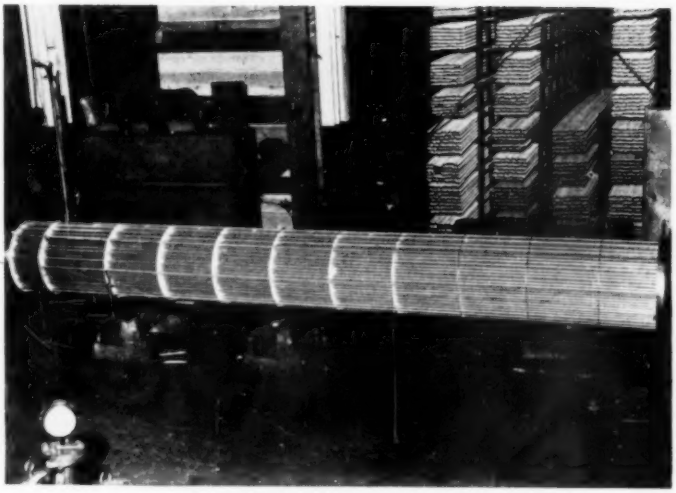
Rearmament needs severely limit the manufacture of aluminum heat exchanger tubes. But we realize that the purchase of refinery and processing equipment requires long study of economic and performance factors. That is the reason for this message.

# El Paso Natural Gas Company Saves 1/3 in Cost of Glycol-Amine Exchanger Tubes

About three years ago, the Fluor Corporation started investigation in corrosion problems occurring with steel exchanger tubes in gas-treating plants utilizing Fluor's glycol-amine process. They conducted extensive research to find suitable replacements for steel. (Results of these tests were reported in the April, 1950, and February, 1951, issues of "Petroleum Refiner" Magazine.) Aluminum and 4-6 cr., ½ moly. steel tubes were most economical of the corrosion-resistant materials tested.

So when Fluor Corporation was selected to engineer glycol-amine exchangers at one of the large new plants of El Paso Natural Gas Company, they recommended Alcoa 3S-H14 aluminum tubes for the service. These tubes cost 30 per cent less than seamless mild steel and 60 per cent less than 4-6 cr., ½ moly. steel. Fabrication of the units was done by Griscom-Russell.

Aluminum heat exchanger tubes have been so successful in resisting corrosion in glycol-amine plant service that over 100,000 pounds of aluminum are now used in that service. Experimental work has indicated over one year of service with no sign of corrosion. In handling, shipping and fabricating costs, the aluminum tubes saved 200,000 pounds over the heavy metal tubes they replaced. Their greater ductility permits easier roll-in.



## ALCOA OFFERS BOOKLET

This 24-page booklet will answer many of your questions about Alcoa Tubes. It covers fabrication techniques, alloy selection, chemical and petroleum applications. It describes tube cleaning, inhibitors, cathodic protection. It contains complete information on fluid flow and heat transfer. There are formulas, tables and specification data. Write for your free copy today. ALUMINUM COMPANY OF AMERICA, 1863-M Gulf Bldg., Pittsburgh 19, Penna.

## THESE APPLICATIONS ARE NATURALS FOR ALUMINUM TUBES:

***Petroleum***

- Condensers handling hydrocarbon fractions such as gasoline, naphtha, gas, oil, etc.
- Vapor recovery condensers
- Lube oil coolers
- Natural gas compressor aftercoolers
- TCC overhead condensers
- Recompressor aftercoolers
- Hydrogen sulfide gas coolers
- Furfural condensers and heat exchangers
- Propane chilling
- Wax sweaters
- Lean oil—rich oil exchangers
- Amine solution coolers
- Glycol-amine solution coolers and heat exchangers.

***Chemical***

- Butanol
- Ethanol
- Ethylene Glycol
- Glycerin
- Hydroabietyl
- Isopropanol
- Methanol
- Phenol
- Propylene Glycol
- Acetaldehyde
- Formaldehyde
- Furfural
- Heptaldehyde
- Acetic acid
- Butyric acid
- Stearic, Palmitic, Maleic Oleic acids
- Naphtha
- Ricinoleic acid
- Acetanilide
- Ammonia
- Hydrogen Cyanide
- Nitric acid (concentrated)
- Pyridine
- Hydrogen Sulfide
- Benzene
- Dichlorobenzene
- Gasoline
- Gelatin
- Hydrogen Peroxide
- Turpentine
- Xylene

board. New directors elected were: David C. Barry, M. Herbert Eisenhart, Karl H. Hubbard, Harry Y. Norwood, Arthur F. Reed and Thomas M. Stewart.

### Personnel Changes

**Fluor Corp.** — Maynard Born to head newly-created defense projects engineering department with a staff of 120, established to coordinate Fluor's contracts, especially military.

**Godfrey L. Cabot, Inc.**—Thomas D. Cabot elected as vice chairman of the Board of Directors and executive vice president; Dr. Godfrey L. Cabot re-elected as president and elected chairman of the board; and Ralph Bradley re-elected treasurer.

**Girdler Corp.** — Ellis T. Beck to Eastern District manager of Votator Division, Louisville, Ky., succeeding Samuel Welch.

**The Carborundum Co.**—Roy W. Brown appointed direct sales representative in a new sales territory in the southwest.

**American Brake Shoe Co.**—William M. Black appointed president and Joseph L. Mullin, vice president, of Electro-Alloys division; Walter G. Hoffman, formerly president of Electro-Alloys division appointed assistant to the vice president for Research and Development.

**Orbit Valve Co.**—Jack Judd transferred from the Houston sales branch to the Midland, Texas office and L. E. Wallace, who formerly headquartered at Corpus Christi, Texas, to the Houston branch. Ralph H. Soape will take over the Corpus Christi territory.

**Chiksan Co.**—L. J. Smith to the newly-created position of Eastern Regional sales manager in the company's Newark, N. J., office.

**Pennsylvania Flexible Metallic Tubing Co.**—George Walker Scudder, Jr., elected to the Board of Directors. Mr. Scudder is president of the Bingham Co. of Philadelphia.

### Expansion, Transition

**Black, Sivalls & Bryson, Inc.,** announced the opening of a Los Angeles office. Ross Baze, west coast sales manager, will be in charge. They will handle a complete line of oilfield products, safety heads and BS&B "Climax" controls. Located at 1274 La Brea Ave.

Also announced was the opening of a Philadelphia sales office in the Fromfield Bldg., 100 E. Lancaster Ave., Wayne, Pa., mailing address, Box 351. Walter Whetstone is the manager and he will be assisted by Seymour Hawley.

**Bigelow-Liptak Corp.** has celebrated its 25th anniversary by moving its general offices to 2550 W. Grand Blvd., Detroit 8, Mich. The new location affords larger and modernized facilities.

**Hooker Electrochemical Co.,** Niagara Falls, plans to build a new $10,000,000 plant for the manufacture of chlorine and caustic soda at Montague, Mich. Expected to be in operation by the end of 1953, with a yearly production rate of approximately 100,000 tons of all products, the plant is intended to serve Midwest industry.

**Marley Co., Inc.,** announces the opening of its Washington, D. C. engineering service office, with Don Cousins as manager. Marley, manufacturers of water cooling towers and air-cooled heat exchangers, will be located in the Wyatt Bldg., 777 Fourteenth St., N. W.

NOW...More Than Ever...
PROTECT YOUR TANKS!
Shortages of steel, for new tankage and repair of old, necessitates your making every tank last as long as possible.
NATASCO protective coatings prevent corrosion damage of new tanks and provide many additional years of service from old ones.
Trained application crews provide a complete protection service including preparation of the surfaces, priming and application, assures maximum results. Your request for full particulars will receive prompt attention. Telephone, wire or write.
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Lease Tank Service—West Texas Area:
Williams Construction Co.
Odessa, Texas
California Representative:
Coast Contractors, Inc.
2627 Atlantic Ave., Long Beach 6, Calif.




(To obtain more data on advertised products see page 1428)

# Fluid Hydroforming

## ANNOUNCEMENT

☆

Arthur G. McKee & Company

are authorized to design and construct Fluid Hydroforming Units. This process employs the "fluid" principle so widely and successfully used in Catalytic Cracking to obtain a high yield of high-octane gasoline with low first cost.

**DESIGN, ENGINEERING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES**

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*Headquarters:* McKee Building, 2300 Chester Avenue, Cleveland 1, Ohio. *New York Office:* 30 Rockefeller Plaza, New York 20, N.Y. • *Washington Office:* 1507 M Street, N. W. Washington, D. C. • *England:* The Iron and Steel Division of Arthur G. McKee & Company is represented by Head, Wrightson & Company, Ltd. *District Engineering Offices:* Union, New Jersey and Tulsa, Oklahoma.

# Survey of Surface Chemistry Is Valuable Book for Petroleum Man

*The Surface Chemistry of Solids*, by S. J. Gregg. 5½ x 8½ in., ix + 297 pages, illustrated, indexed, stiff cloth binding, $8.50. Reinhold Publishing Corp., 330 West 42nd St., New York 18, N. Y.

It goes almost without saying that today's petroleum processes are no longer the relatively simple physical separation techniques they once were. Rather, they have become comparatively complex chemical processes, demanding of design, process, and operating engineers a steadily increasing knowledge and command of the science of physical chemistry.

One of the most important principles affecting today's processes—particularly catalysis, chemical absorption and adsorption among others—is that of the *Surface Chemistry of Solids*. Also tied in are the mechanics of adhesion, lubrication, and detergency. A new book treating with this phenomenon is therefore very much in order, in many technical fields certainly and in petroleum processing quite definitely.

This new book presents a brief, but systematic, survey of the various branches of the surface chemistry of solids. It covers all phenomena relating to the activity taking place on the surface of a solid, or in the so-called interface between a solid and a gas, a solid and a liquid, or between two solids.

A rundown of some of the chapter headings gives a quick picture of the kind of information presented: adsorption of gases and vapors by solids; adhesion and the effect of adsorption on it; films on the surfaces of liquids; the external surface of a solid, porosity, permeability, smoke and dust; friction and lubriction; adsorption from liquids, chromotography; catalysis and chemisorption; the part played by surface in chemical reactions.

Dr. Gregg, the author, is lecturer in surface chemistry at the University College of the South-West of England, Exeter. Printed in England by Chapman and Hall Ltd. of London, the book is made available in this country by Reinhold.

## 1951 Petroleum Standards Published in ASTM Manual

*A.S.T.M. Standards on Petroleum Products and Lubricants* (With Related Information), 1951 Edition; American Society for Testing Materials Committee D-2; 6 x 9 in., xx + 784 pages, in heavy paper cover, $5.75; cloth cover, $6.40. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

This edition, compiled by ASTM Committee D-2 on Petroleum Products and Lubricants, gives in their latest form, 129 ASTM standards, including 116 test methods; 7 specifications; 1 classification; 3 lists of definitions relating to petroleum, specific gravity, and rheological properties of matter; 2 tentative recommended practices for the purchase of uninhibited mineral oil for use in transformers and in oil circuit breakers, and for designating significant places in specified limiting values; and other material.

New material includes tentative test methods for: total inhibitor content (p-tertiary-butylcatechol) of butadiene; bromine number of petroleum distillates (color indicator and electrometric methods); reduced pressure distillation of petroleum products; and hydrocarbon waxes used for electrical insulation.

Appendices include proposed methods of test for: penetration of lubricating greases worked more than 60 strokes; measurement of density and specific gravity of liquids to the fifth place by the Bingham pycnometer; saponification number of petroleum products (para-xylenol blue color-

HEAT EXCHANGERS

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THE *quickest* and (in the long run) *cheapest* way to clean tubular heat exchangers is the *in-place* method of circulating hot solutions of chemical cleaning compounds. Much quicker, more thorough than lancing with air or steam. No danger of damage to metal surfaces as with rodding, drilling, or fish-sawing.

For the complete Oakite story on cleaning and descaling exchangers, other equipment, write nearest address below. Interesting literature—personal in-plant services freely available to you without obligation. Send today to Oakite Products, Inc., 44C Thames Street, New York 6, N. Y.

SEND for this FREE Booklet. It is full of useful information on general maintenance cleaning. Covers all divisions of the Petroleum Industry—production, processing, transportation, marketing.

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Soda Ash · Caustic Soda · Caustic Potash · Nytron · Calcium Chloride
Chlorine · Potassium Carbonate · Sodium Bicarbonate · Formaldehyde
Specialty Cleansers · Ammonium Bicarbonate · Sodium Nitrite
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St. Louis · Syracuse




*(To obtain more data on advertised products see page 1428)*

indicator method); oil content of petroleum waxes; kinematic viscosity; and two proposed methods of determining motor and research octane numbers of small samples.

There are also recommendations on the form of ASTM methods of test for petroleum products and lubricants; list of proposed methods prepared by Committee D-2 and published as information prior to 1950; other ASTM publications on petroleum products and lubricants; and regulations governing ASTM Committee D-2.

## New Edition of API Manual Covers Chemical Wastes

*Manual on Disposal of Refinery Wastes, Vol. III, Chemical Wastes*, 2nd edition; 8½ x 11 in., 40 pages including paper cover. $1.50. American Petroleum Institute, Division of Refining, 50 West 50th St., New York 20, N. Y.

Latest addition to the literature on refinery waste disposal is a revised edition of Vol. III of the API *Manual on Disposal of Refinery Wastes*, dealing with chemical wastes. It replaces the first edition, published in 1935, and brings up-to-date all information with the API Committee on Disposal of Refinery Wastes has been able to collect to the subject.

Five chapters in the 40-page booklet describe the properties and sources of chemical wastes, the effects of pollution of surface waters by chemical wastes, methods and devices for the treatment and control of chemical wastes, and some recommended practices covering equipment and operation of disposal facilities.

## Packed Tower Design Book Should Help Oil Engineers

*Tower Packings and Packed Tower Design*, by Max Leva; 7⅝ x 10¼ in., 120 pages, stiff cloth binding, illustrated, indexed. The United States Stoneware Co., Akron 9, Ohio.

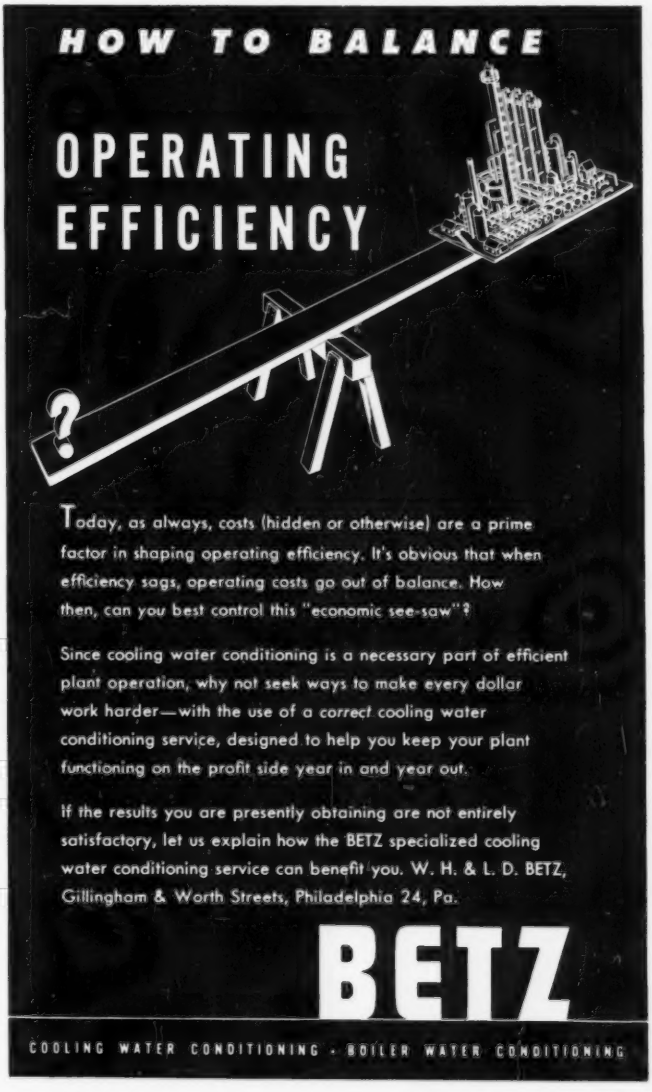
A commonly-used piece of process equipment in the petroleum plant is the packed tower useful in such typical operations as absorption, stripping, distillation, scrubbing and extraction. Packed towers, however, must be designed and engineered; they are not purchased as ready-to-use units like dryers, filters, mixers, etc. *Tower Packings and Packed Tower Design* represents an excellent new manual, or handbook, on this problem; particularly in one specific phase, that wherein the packed tower contains specially-shaped ceramic bodies.

The book treats first with general considerations and the mechanics of packed tower operation. It then goes on with some typical sample problems, explaining fundamentals, and on to a discussion of absorption data and packing performance, and distillation data. A very complete appendix augments the already complete data, charts, and tables.

The publishers must be commended for an excellent job of printing and illustration reproduction as well as for a good index, a must for any book of this type.

Two other features make this book a very useful engineering tool. First, there are extra copies of a number of nomographs. The original nomographs appear in their proper place in relationship to the text within the book. The extra copies are good working charts and have been placed in a handy pocket attached to the inside back cover. Secondly, the publishers have solved another ever-present problem in technical books. Where tables are printed on pages other than those on which they are referred to in the text, a small side-note is printed referring the reader to the proper page to find the table involved.

Published by U. S. Stoneware, the book is available without charge to engineers with a direct interest or concern with the problem of packed towers. Copies may be obtained by writing direct to U. S. Stoneware Co., Akron 9, Ohio.



HOW TO BALANCE
OPERATING EFFICIENCY
?
Today, as always, costs (hidden or otherwise) are a prime factor in shaping operating efficiency. It's obvious that when efficiency sags, operating costs go out of balance. How then, can you best control this "economic see-saw"?
Since cooling water conditioning is a necessary part of efficient plant operation, why not seek ways to make every dollar work harder—with the use of a correct cooling water conditioning service, designed to help you keep your plant functioning on the profit side year in and year out.
If the results you are presently obtaining are not entirely satisfactory, let us explain how the BETZ specialized cooling water conditioning service can benefit you. W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa.
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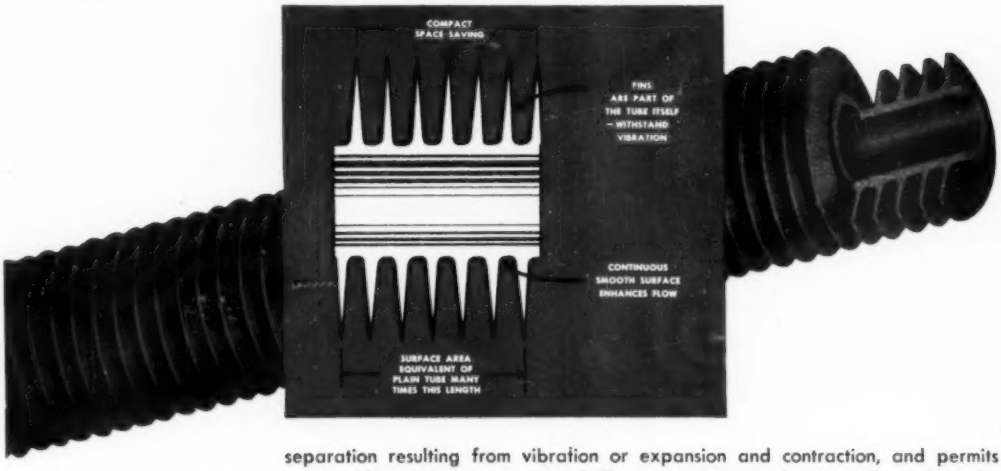
*(To obtain more data on advertised products see page 1428)*

# HIGHER EFFICIENCY from less working space

These six words briefly describe the noteworthy performances that Wolverine Trufin*—the integral finned tube—is showing wherever it forms a part of heat exchangers.

As if developed expressly for the defense effort, Trufin is THE answer to today's cry for more production because it possesses the physical advantages of greater capacity.

Just a glance at its unique construction will tell you why Trufin performs so well. Note that the fins are part of the tube itself. Thus there is a positive, uninterrupted thermal flow. This one-piece construction removes the hazard of fin and tube


COMPACT SPACE SAVING
FINS ARE PART OF THE TUBE ITSELF — WITHSTAND VIBRATION
CONTINUOUS SMOOTH SURFACE ENHANCES FLOW
SURFACE AREA EQUIVALENT OF PLAIN TUBE MANY TIMES THIS LENGTH

separation resulting from vibration or expansion and contraction, and permits more uniform temperature control. The space-saving advantage is obvious; the equivalent outside surface area of a 19" length of plain tube, ⅝" diameter, for instance, can be obtained in just one inch length of Trufin of the same diameter. The continuous, smooth surface between the fins, too, enhances the flow of liquids through them and lessens the tendency for the formation or accumulation of obstructions that necessitate more frequent cleaning.

Trufin is available in a variety of alloys, including bi-metal; in a wide range of sizes, fin spacings and heights. If you are retubing or installing new heat exchangers or condensers, consider Trufin—the tube recognized for its high efficiency.

Would you like a Bulletin that gives detailed information about operating heat exchangers efficiently? Ask for a copy on your stationery. *Reg. U. S. Pat. Off.

*Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.*

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Calumet & Hecla Consolidated Copper Company
INCORPORATED
*Manufacturers of seamless, nonferrous tubing*
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Wolverine Condenser tubes stocked by Butler Industries, Inc., 355 South Fourth Street, Beaumont, Texas. Telephone Beaumont 5-2351.

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## MEETINGS

### *Third Maintenance Conference Is Five Times Larger than First*

MANLY Fleischmann, administrator, Defense Production Administration, discussing "Plant Maintenance in National Defense," will head a group of 56 speakers scheduled for the third annual Plant Maintenance Conference at Convention Hall, Philadelphia, Jan. 14-17. He will speak at the annual banquet on Wednesday evening, Jan. 16, at the Warwick Hotel.

Other speakers during the six conference sessions at Convention Hall will cover the entire field of maintenance—costs, project preparation, inspection methods, scheduling, training, operating policies, safety, etc., in their relationship to the following general industrial fields: petroleum, chemical processing, metal, aircraft, textiles, food, glass, printing, pulp and paper. In addition, special papers will be presented on maintenance of plant buildings, electrical equipment, chemical plants, and the like.

More than 14,000 are expected to attend the conference, which will be held in conjunction with the annual Plant Maintenance Show, at which 225 companies are expected to exhibit. The displays will cover a floor area five times that of the first such show held in Cleveland two years ago. Special emphasis will be placed both in the show and in the conference on preventive maintenance to help meet the huge military and civilian production schedules of 1952.

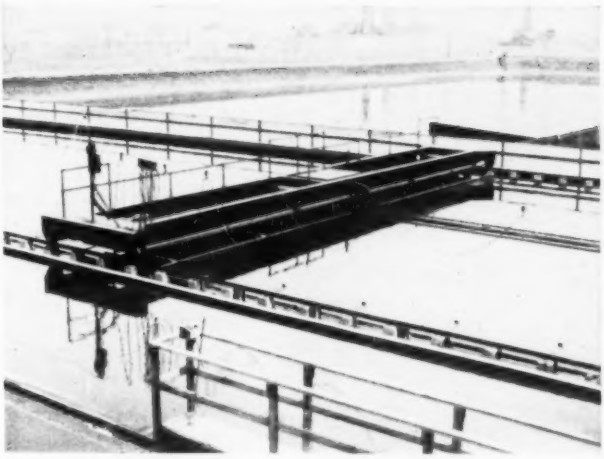
The conference is sponsored by the American Society of Mechanical Engineers and the Society for the Advancement of Management. The American Society of Lubrication Engineers conducts the panel on lubrication.

### *ASM—Metal Shortage To Be Main Topic of Special Meeting*

FIVE aspects of strategic metal conservation and substitution will be discussed by top experts in these fields at the American Society for Metals' first midwinter technical meeting, Jan. 31-Feb. 1, at the William Penn Hotel, Pittsburgh, Penna.

Four papers covering titanium and its alloys will be presented on Thursday morning, Jan. 31. In the afternoon, five papers will be given on the problem of embrittlement of both iron and steel. Three more papers are scheduled to follow a banquet on Thursday evening and will be devoted to high temperatures and oxidation. Sessions on Friday will include papers on metallurgy in the nonferrous field and fundamentals of transformation and grain size.

The decision to hold a special midwinter meeting as a supplement to the annual meeting in June was made

Typical installation of Hardinge Rectangular Clarifiers in oil refinery installation for treatment of waste water. These clarifiers remove oil and sludge from the water.

HARDINGE SEPARATORS TREAT 30 MILLION GALLONS OF OIL REFINERY WASTE WATER DAILY

A recent installation of Hardinge Rectangular Clarifiers, for separating oil from the refinery waste water, handles 20,800 gallons per minute—nearly 30 million gallons a day. The skimmers remove 35 gallons per minute of oil from the water surface or more than 50,000 gallons per day.

This installation, occupying more than 2 acres, employs five Hardinge units. Thousands of dollars were saved on this installation because Hardinge equipment could be used with existing settling tanks.

HARDINGE
COMPANY, INCORPORATED
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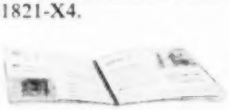
**model 21-401 mass spectrometer**

*an analytical and isotope-ratio mass spectrometer combined*

CONSOLIDATED'S new Model 21-401 Mass Spectrometer is a compact, medium-priced instrument, ideal for those laboratories having only moderate analytical loads. Highly versatile, it provides not only quantitative analyses of gaseous or light-liquid mixtures as automatically recorded mass spectra, but *also* precise *recorded* ratios of stable gaseous isotopes. Like the widely used Model 21-103, it is exceptionally accurate and incorporates many automatic, time-saving features. For the multitude of industrial and scientific applications not requiring extremes of mass range, sensitivity, and operating speed, the Model 21-401 is of maximum value. Further information is contained in Bulletin CEC-1821-X4.

*The widely used Model 21-103 Mass Spectrometer for broad applications - analytical and research.*

*Model 21-201 Isotope-Ratio Mass Spectrometer - specifically for measuring ratios of stable isotopes in gases.*



**CONSOLIDATED ENGINEERING**
*Corporation*

*Analytical Instruments*
*300 No. Sierra Madre Villa*

CEC

*for Science and Industry*
*Pasadena 8, California*



*(To obtain more data on advertised products see page 1428)*



by the ASM Trustees as a means of discussing highly important metallurgical developments which could not be scheduled at the annual Congress because of time limitations.

### SAE—Annual Meeting Is Set For Detroit, January 14-18

THE influence of motor oil characteristics on combustion chamber deposits, resulting from an engine laboratory study made by Phillips Petroleum Co., will be reported at the January 17 session of the annual meeting of the Society of Automotive Engineers in the Book-Cadillac Hotel, Detroit, January 14-18. Contributing to the motor oil report are D. E. Carr, L. A. McReynolds, S. C. Britton, and R. E. Linnard, all of Phillips.

Other papers to be presented at the same session, which is sponsored by the SAE Fuels and Lubricants Committee, include:

"Field Performance of Detergent Type Oils in Gasoline Powered Vehicles," by A. C. Pilger, Tide Water Associated Oil Co.

"A Study of Factors Affecting Diesel Lubricant Performance," by H. C. Morris, The Texas Co.

"A Test for Anti-Freeze Contamination in Crankcase Oil," by George J. Liddell and Ruth Marshall, Sun Oil Co.

The technical session on Jan. 18 will feature a symposium on how modern computing machines can help the engineer.

### Oil Man's Calendar

**JANUARY, 1952**

**Plant Maintenance Show and Conference,** Convention Hall, Philadelphia, Penna., Jan. 14-17.
**Society of Automotive Engineers,** annual meeting, Hotel Book-Cadillac, Detroit, Mich., Jan. 14-18.
**American Institute of Electrical Engineers,** winter general meeting, Hotel Statler, New York City, Jan. 21-25.
**American Society for Metals,** midwinter technical meeting, William Penn Hotel, Pittsburgh, Penna., Jan. 31-Feb. 1.

**MARCH**

**Mfgrs. Standardization Society of Valve & Fittings Industry,** annual meeting, Hotel Commodore, New York City, March 3-5.
**American Society for Testing Materials,** spring meeting and committee work, Hotel Statler, Cleveland, Ohio, March 3-7.
**National Electrical Manufacturers' Association,** Edgewater Beach Hotel, Chicago, Ill., March 10-13.
**National Association of Corrosion Engineers,** 8th annual conference and exhibition, Municipal Pier, Galvez and Buccaneer Hotels, Galveston, Texas, March 11-14.
**American Institute of Chemical Engineers,** regional meeting, Biltmore Hotel, Atlanta, Ga., March 16-19.
**Western Petroleum Refiners Association,** annual meeting, The Plaza Hotel, San Antonio, Texas, March 31-Apr 2.

**APRIL**

**National Packaging Exposition,** Auditorium, Atlantic City, N. J., April 1-4.
**National Petroleum Association,** semi-annual meeting, Hotel Cleveland, Cleveland, Ohio, April 16-18.
**Natural Gasoline Association of America,** 31st annual convention, Rice Hotel, Houston, Texas, April 30-May 2.

## CATALYST FACTS YOU MAY NOT KNOW:

*Acceptance-*

*Price-*

*Volume-*

*Experience-*

*Service-*

*Sulfur-*

*Adaptability-*

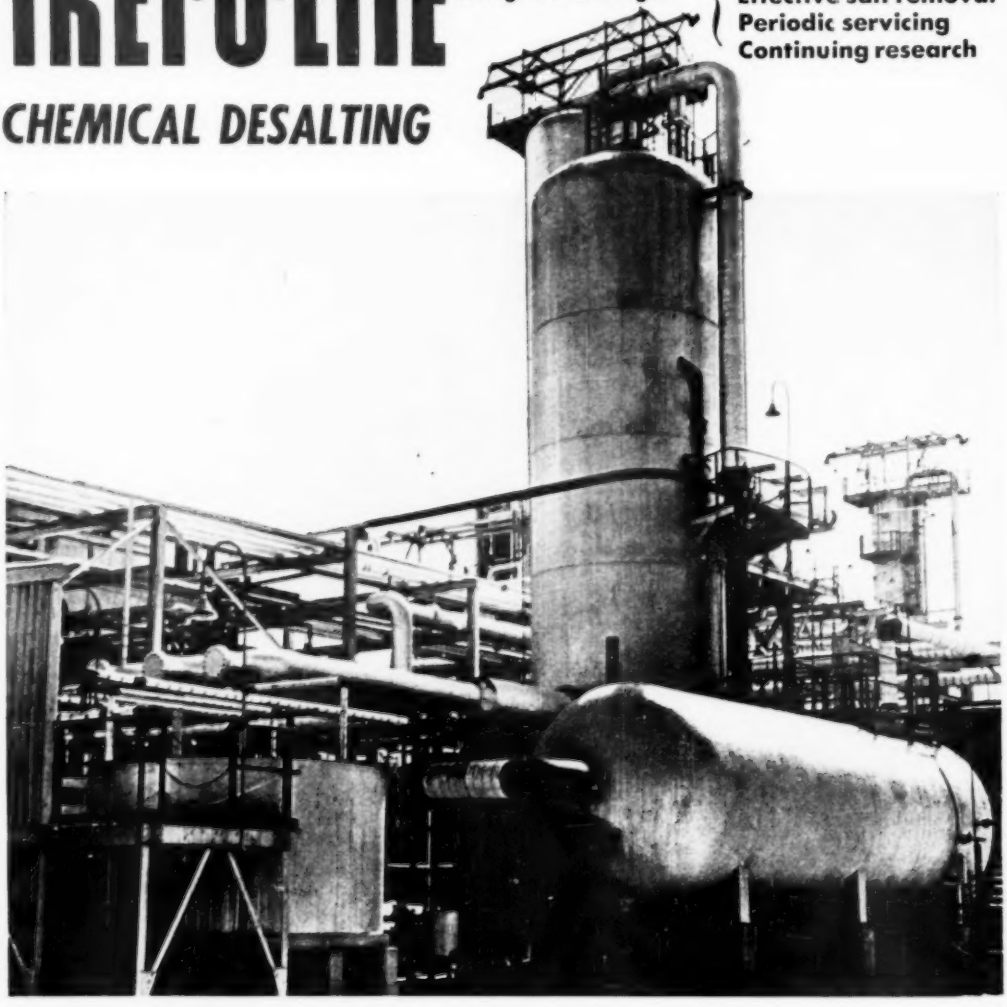
*Filtrol**

# TRETOLITE

ensures these money-saving advantages

- Low installation costs
- Low operating costs
- Effective salt removal
- Periodic servicing
- Continuing research

## CHEMICAL DESALTING



**HIGH EFFICIENCY**

**LOW COST**

In many of America's leading refineries Tretolite desalting is delivering salt removals as high as 90 to 95%. The low water requirement seldom exceeds 5 to 8% of the total volume of the crude charge. Tretolite desalters now in use range in capacity from 2,000 to 50,000 barrels per day per plant, since Tretolite desalting is adaptable to either large or small refining operations. Periodic checking by Tretolite desalting engineers insures that your Tretolite desalting process stays at top operating efficiency.

The recognized economy of Tretolite desalting is due to the high flexibility of the process. This process flexibility often permits the use of existing refinery equipment as part of the desalting installation, obviously holding installation costs at a minimum. This low installation cost, plus the low water, heat and chemical requirements, helps to hold Tretolite desalting cost per barrel at a minimum.

**TRETOLITE COMPANY** *Chemicals for the Petroleum Industry*

ST. LOUIS 19, MISSOURI • LOS ANGELES 22, CALIFORNIA

DESALTING • DEHYDRATING • WATER DE-OILING • CORROSION INHIBITION • SCALE PREVENTION

TD 51-1

## REFINING TRENDS

**Current Data on Crude Runs, Product Supply and Demand**

# U.S. Refiners "Find" 185,000 B/D Additional Operating Capacity

THE discovery that U.S. refiners have been operating in recent months with around 185,000 bbls. more plant capacity than the generally accepted total has changed some views on current operations as well as on possible future trends.

In place of total refining capacity on Sept. 30 being 7,040,650 bbls., actual capacity on that date was 7,227,400 bbls., about 2.2% larger, the API Department of Statistics reports. The former figure was based on estimates made by the oil companies last spring as to what their operable capacities would be on Sept. 30. The new figure is based on a recent survey by the API bureau. The API believes the matter important enough to refiners that the new figure was announced to them ahead of the publication of the regular API survey. Table 1 shows the new and old capacity estimates by districts.

The unanticipated increase, it is believed, has come about mostly through the efforts of many individual refinery staffs to remove operating bottlenecks and bring their plants up to maximum operable capacity. New construction coming on stream is some factor and is expected to be more of a factor in the future.

Based on the additional plant capacity, crude runs of 6,500,000 b/d are around 90.5% of operable capacity, in place of 94% as reported on the old figure. Runs of 6,757,000 b/d as reported for the week ending Nov. 24 are about 93.5% of capacity. It is thus indicated that crude runs in the immediate future can be further increased, if required.

Some operators believe that continued runs of this volume are not justified under present conditions; even in the face of reductions in heating oil stocks east of the Rockies of 4,800,000 bbls. and of around 5,500,000 bbls. for the entire U.S., in the first 24 days of November, brought about by the low temperatures over a wide area of the country in early November. In all of November, 1950, stocks of heating oils (kerosine and distillates) were reduced by less than 2,000,000 bbls.

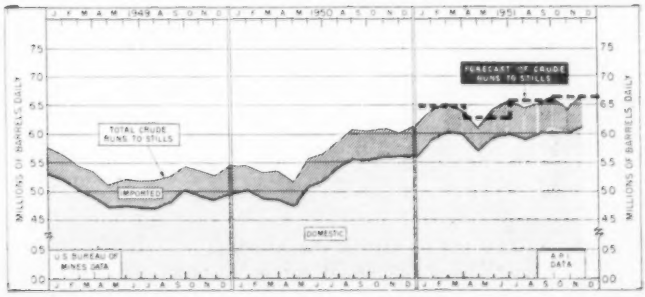
Heating oil stocks in refineries east of California on Nov. 1 were around 126,700,000 bbls. and for the entire country around 136,100,000 bbls. East of California these stocks on Nov. 1 were nearly 25,500,000 bbls. higher than on the same date in 1950, and for the entire U.S. they were about 22,000,000 bbls. larger. This additional volume could be eaten away fairly quickly in the event of continued cold weather in the early part of the winter, since consumption under normal winter temperatures is estimated to be 10% or more greater this winter than last. However, particularly in view of the larger refining capacity to draw on which is now recognized, some refiners believe it will be economic to hold down crude runs and to increase distillate yields, if required to meet this winter's demands. Present distillate yields for the U.S. are around 20% of crude runs, as compared with over 21.5% in some months last winter.

A critical factor if crude runs this winter are maintained at high levels could be the buildup this winter in gasoline stocks. This year gasoline stocks reached their low point in early November, when they were around 109,500,000 bbls. for the U.S. and about 95,500,000 bbls. east of California. A year ago gasoline stocks started to build up in October from a low point of 103,500,000 bbls. for the entire U.S. and 91,000,000 bbls. east of the Rockies.

**Table 1—Revised Estimates of Sept. 30 Refinery Operating Capacities**

| Refining District | Revised Estimate | Previous Estimate | Per Cent Increase |
|---|---|---|---|
| East Coast | 1,094,200 | 1,056,700 | 3.5 |
| Appalachian No. 1 | 115,700 | 115,750 | ... |
| Appalachian No. 2 | 87,300 | 87,300 | ... |
| Ind.-Ill.-Ky. | 1,318,600 | 1,292,300 | 2.0 |
| Okla.-Kans.-Mo. | 596,600 | 586,200 | 1.8 |
| Inland Texas | 291,400 | 269,350 | 8.2 |
| Texas Gulf | 1,667,100 | 1,608,150 | 3.6 |
| Louisiana Gulf | 507,900 | 497,500 | 1.9 |
| N. La.-Arkansas | 88,300 | 86,250 | 2.4 |
| New Mexico | 21,500 | 19,550 | 9.9 |
| Other Rocky Mt. | 249,500 | 241,400 | 3.4 |
| East of California | 6,037,200 | 5,860,450 | 3.0 |
| California | 1,190,200 | 1,180,200 | 0.8 |
| Total U. S. | 7,227,400 | 7,040,650 | 2.2 |

**Fig. 1—Crude Runs Reach 6,750,000 B/d in One Week**


J F M A M J J A S O N D 1949 J F M A M J J A S O N D 1950 J F M A M J J A S O N D 1951
MILLIONS OF BARRELS DAILY
TOTAL CRUDE RUNS TO STILLS
FORECAST OF CRUDE RUNS TO STILLS
IMPORTED
DOMESTIC
U.S. BUREAU OF MINES DATA
A.P. DATA

### Crude Runs to Stills

Daily Average (1000 bbls.)

| | Domestic | Foreign | TOTAL |
|---|---|---|---|
| Nov. '51 API* | 6,173 | 462 | 6,635 |
| Nov. '50 BM | 5,614 | 471 | 6,085 |
| Change | +559 | −9 | +550 |
| % Change | 9.9 | 1.9 | 9.0 |

*Through Nov. 24

Total (1000 bbls.)
(Bureau of Mines Data)

| | | | |
|---|---|---|---|
| 10 Mos. 1951* | 1,812,725 | 154,527 | 1,967,252 |
| 10 Mos. 1950 | 1,575,367 | 146,513 | 1,721,880 |
| Change | +237,358 | +8,014 | +245,372 |
| % Change | 15.7 | 5.5 | 14.2 |

*October from API data

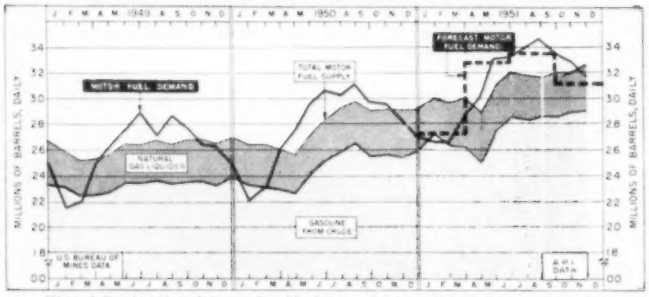
BM Forecast of Crude Runs to Stills, 1951
(Revised Sept. 25; 1000 b/d avg. by Quarters)
1st Q., 6,492; 2nd Q., 6,398; 3d Q., 6,558; 4th Q., 6,509

### Yield on Crude Runs to Stills

| | Gasoline % | Kerosine % | Dist. Fuels % | Resid. Fuels % |
|---|---|---|---|---|
| Nov. '51 API* | 43.2 | 6.1 | 20.3 | 19.8 |
| Oct. '51 API | 44.0 | 5.6 | 20.3 | 18.8 |
| Sept. '51 BM | 43.2 | 5.6 | 19.6 | 18.8 |
| Nov. '50 BM | 42.0 | 5.6 | 20.0 | 20.3 |

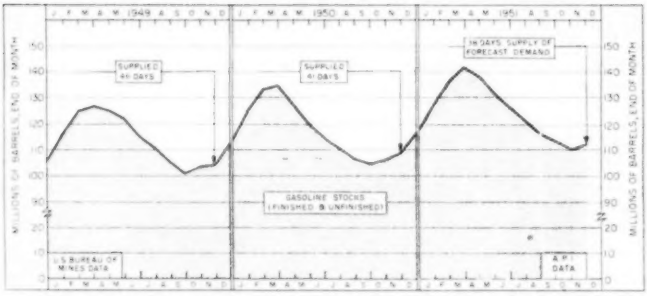
*Through Nov. 24

## Fig. 2—Motor Fuel Supply Above Summer Level

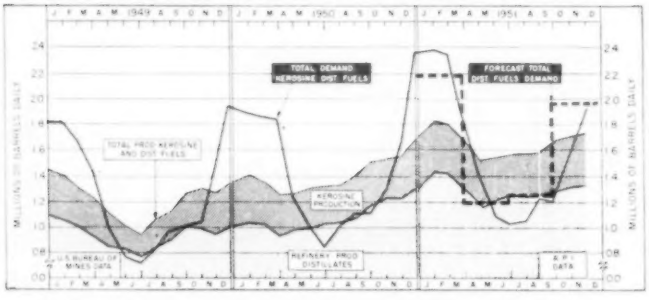



*Natural Gas Liquids include gasoline blended at refineries and used direct as motor fuel

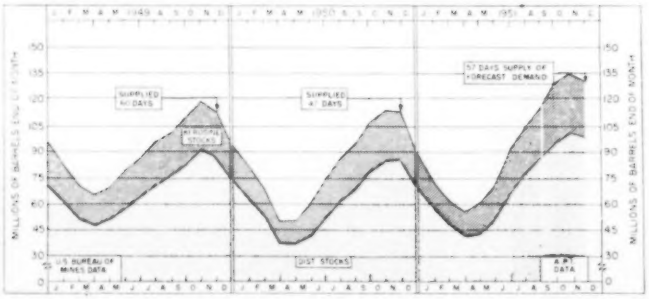
## Fig. 3—"Gas" Stocks Buildup Starts in November


SUPPLIED 46 DAYS
SUPPLIED 41 DAYS
18 DAYS SUPPLY OF FORECAST DEMAND
GASOLINE STOCKS (FINISHED & UNFINISHED)
MILLIONS OF BARRELS, END OF MONTH
U.S. BUREAU OF MINES DATA
A.P.I. DATA

## Fig. 4—Seasonal Spurt in Heating Oil Demand


TOTAL DEMAND KEROSINE DIST. FUELS
FORECAST TOTAL DIST. FUELS DEMAND
TOTAL PROD KEROSINE AND DIST. FUELS
KEROSINE PRODUCTION
REFINERY PROD DISTILLATES
MILLIONS OF BARRELS DAILY
U.S. BUREAU OF MINES DATA
A.P.I. DATA

## Fig. 5—November Cuts into Heating Oil Stocks




### Motor Fuel Supply

Daily Average (1000 bbls.)

| | Gasoline from Crude | Natural Blended Used Direct | TOTAL |
|---|---|---|---|
| Nov. '51 API* | 2,865 | 365 | 3,230 |
| Nov. '50 BM | 2,561 | 350 | 2,911 |
| Change | +304 | +15 | +319 |
| % Change | 11.9 | 4.2 | 10.9 |

*Through Nov. 24

Total (1000 bbls.)
(Bureau of Mines Data)

| | | | |
|---|---|---|---|
| 10 Mos. '51* | 837,417 | 107,041 | 944,458 |
| 10 Mos. '50 | 746,417 | 99,684 | 846,101 |
| Change | +91,000 | +7,357 | +98,357 |
| % Change | 12.2 | 7.4 | 11.6 |

*October from API data

### Motor Fuel Demand

Including Exports
Daily Average (1000 bbls.)

| | |
|---|---|
| Nov. '51 API* | 3,170 |
| Nov. '50 BM | 2,825 |
| Change | +345 |
| % Change | 12.2 |

*Through Nov. 24

Total (1000 bbls.)
(Bureau of Mines Data)

| | |
|---|---|
| 10 Mos. '51* | 946,795 |
| 10 Mos. '50 | 850,957 |
| Change | +95,838 |
| % Change | 11.3 |

*October from API data

BM Forecast of Motor Fuel Demand, 1951
(Revised Sept. 25; 1000 b/d avg. by Quarters)
1st Q., 2,732; 2nd Q., 3,210; 3d Q., 3,348; 4th Q., 3,109

### Gasoline Stocks

Finished and unfinished, end of month (1000 bbls.)

| | |
|---|---|
| Nov. '51 API* | 111,700 |
| Oct. '51 API | 110,200 |
| Sept. '51 BM | 114,147 |
| Nov. '50 BM | 109,005 |

*On Nov. 24

### Heating Oils Production

(Kerosine and Distillates)
Daily Average (1000 bbls.)

| | Kero-sine | Dist. Fuels | TOTAL |
|---|---|---|---|
| Nov. '51 API* | 405 | 1,350 | 1,755 |
| Nov. '50 BM | 342 | 1,218 | 1,560 |
| Change | +63 | +132 | +195 |
| % Change | 18.4 | 10.8 | 12.5 |

*Through Nov. 24

Total (1000 bbls.)
(Bureau of Mines Data)

| | | | |
|---|---|---|---|
| 10 Mo. '51* | 117,490 | 291,133 | 392,623 |
| 10 Mo. '50 | 86,996 | 330,754 | 417,750 |
| Change | +14,494 | +70,379 | +84,873 |
| % Change | 14.9 | 21.9 | 20.3 |

*October from API data

### Heating Oils Demand

Daily Average (1000 bbls.)

| | Kero-sine | Dist. Fuels | TOTAL |
|---|---|---|---|
| Nov. '51 API* | 480 | 1,500 | 1,980 |
| Nov. '50 BM | 434 | 1,217 | 1,651 |
| Change | +46 | +283 | +329 |
| % Change | 10.6 | 23.2 | 19.9 |

*Through Nov. 24

Total (1000 bbls.)
(Bureau of Mines Data)

| | | | |
|---|---|---|---|
| 10 Mo. '51* | 98,468 | 364,853 | 463,321 |
| 10 Mo. '50 | 89,837 | 314,467 | 404,304 |
| Change | +8,631 | +50,386 | +59,017 |
| % Change | 9.6 | 16.2 | 14.6 |

*October from API data

BM Forecast of Heating Oil Demand
(Kerosine and Distillates)
(Revised Sept. 25; 1000 b/d avg. by Quarters)
1st Q., 2,198; 2nd Q., 1,192; 3d Q., 1,214; 4th Q., 1,978

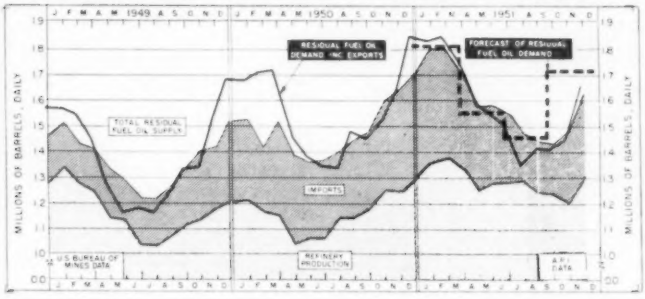
### Heating Oil Stocks

(1000 bbls. end of month)

| | Kero-sine | Dist. Fuels | TOTAL |
|---|---|---|---|
| Nov. '51 API* | 31,661 | 98,986 | 130,647 |
| Oct. '51 API | 33,530 | 102,575 | 136,105 |
| Sept. '51 BM | 33,106 | 96,241 | 129,347 |
| Nov. '50 BM | 25,526 | 86,113 | 111,639 |

* On Nov. 24

## Fig. 6—Sharp Increase in Residual Fuel Output




### Residual Fuels Production

Daily Average (1000 bbls.)

| | Refinery Output | Imports | TOTAL |
|---|---|---|---|
| Nov. '51 API* | 1,315 | 307 | 1,622 |
| Nov. '50 BM | 1,240 | 393 | 1,633 |
| Change | +75 | −86 | −11 |
| % Change | 6.0 | 21.9 | 0.7 |

* Through Nov. 24

Total (1000 bbls.)
(Bureau of Mines Data)

| | | | |
|---|---|---|---|
| 10 Mo. '51* | 389,124 | 95,278 | 484,402 |
| 10 Mo. '50 | 347,540 | 94,719 | 442,259 |
| Change | +41,584 | +559 | +42,143 |
| % Change | 11.9 | 0.6 | 9.5 |

* October from API data

### Residual Fuels Demand

Daily Average (1000 bbls.)

| | |
|---|---|
| Nov. '51 API* | 1,670 |
| Nov. '50 BM | 1,646 |
| Change | +24 |
| % Change | 1.5 |

* Through Nov. 24

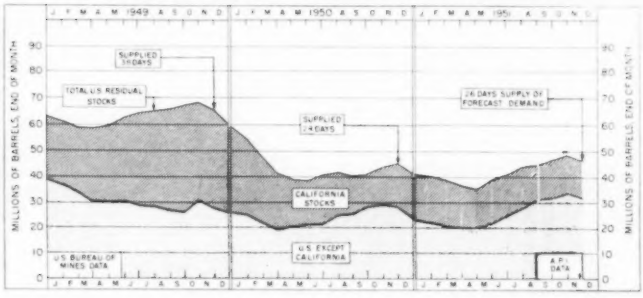
Total Demand (1000 bbls.)

| | |
|---|---|
| 10 Mo. '51* | 480,263 |
| 10 Mo. '50 | 462,286 |
| Change | +17,977 |
| % Change | 3.9 |

* October from API data

BM Forecast of Residual Fuels Demand
(Revised Sept. 28; 1000 b/d avg. by Quarters)
1st Q., 1,825; 2nd Q., 1,543; 3d Q., 1,449; 4th Q., 1,706

## Fig. 7—Moderate Withdrawal of Residual Stocks



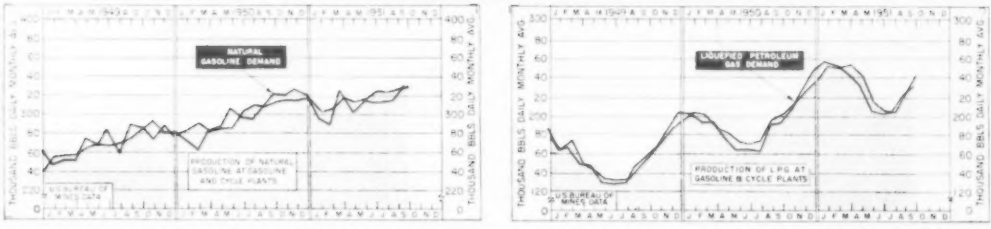

### Residual Fuel Stocks

1000 bbls. end of month

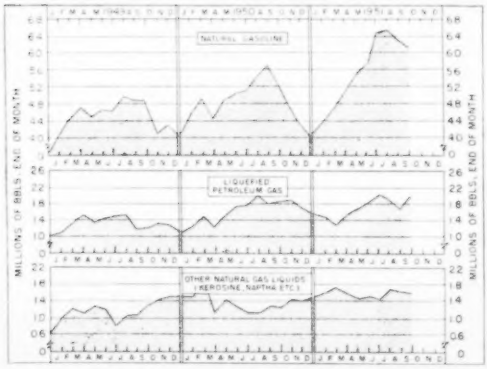
| | U.S. Except California | Total U.S. |
|---|---|---|
| Nov. '51 API* | 32,648 | 47,591 |
| Oct. '51 API | 33,330 | 48,830 |
| Sept. '51 BM | 32,608 | 48,212 |
| Nov. '50 BM | 28,548 | 45,048 |

* On Nov. 24

## Fig. 8—Production and Demand of Natural Gas Liquids


NATURAL GASOLINE DEMAND
PRODUCTION OF NATURAL GASOLINE AT GASOLINE AND CYCLE PLANTS
U.S. BUREAU OF MINES DATA
THOUSAND BBLS DAILY MONTHLY AVG.
LIQUEFIED PETROLEUM GAS DEMAND
PRODUCTION OF LPG AT GASOLINE & CYCLE PLANTS
U.S.B. BUREAU OF MINES DATA
THOUSAND BBLS DAILY MONTHLY AVG.

## Fig. 9—Stocks of Natural Gas Liquids


NATURAL GASOLINE
LIQUEFIED PETROLEUM GAS
OTHER NATURAL GAS LIQUIDS (KEROSINE, NAPTHA ETC.)
MILLIONS OF BBLS. END OF MONTH
MILLIONS OF BBLS. END OF MONTH

### Natural Gas Liquids Statistics

(Source: U. S. Bureau of Mines Report on Natural Gasoline and Cycle Plant Operations)

| | Production (1000 gal./day avg.) Natural Gasoline | LPG** | TOTAL | Demand* (1000 gal./day avg.) Natural Gasoline | LPG | TOTAL |
|---|---|---|---|---|---|---|
| Sept. '51 | 327 | 241 | 568 | 336 | 233 | 569 |
| Sept. '50 | 313 | 202 | 515 | 319 | 194 | 513 |
| Change | +14 | +39 | +53 | +17 | +39 | +56 |
| % Change | 4.5 | 19.3 | 10.3 | 5.3 | 20.1 | 10.9 |
| | Total Production (1000 gal.) | | | Total Demand (1000 gal.) | | |
| 9 Mos. '51 | 86,806 | 63,512 | 150,318 | 85,177 | 62,681 | 147,858 |
| 9 Mos. '50 | 80,552 | 51,050 | 131,602 | 79,565 | 50,007 | 129,572 |
| Change | +6,254 | +12,462 | +18,716 | +5,612 | +12,674 | +18,286 |
| % Change | 7.7 | 24.4 | 14.2 | 7.1 | 25.3 | 14.1 |

Stocks, End of Month (1000 gal.)

| | By Type of Product: Natural Gasoline | LPG | Other Products† | By Location: Refineries | Gasoline Plants | TOTAL |
|---|---|---|---|---|---|---|
| Sept. '51 | 6,042 | 1,904 | 1,632 | 3,286 | 6,292 | 9,578 |
| August '51 | 6,384 | 1,798 | 1,701 | 3,464 | 6,419 | 9,883 |
| Sept. '50 | 5,355 | 1,899 | 1,325 | 2,676 | 5,905 | 8,581 |

* Demand, including exports but not transfers, is supplied from receipts from outside sources as well as current production and stock changes at gasoline plants. Outside receipts in September totaled 140,000 bbls.

** Does not include LPG produced at refineries which in September totaled 2,530,000 bbls.

† Includes naphtha, kerosine, specialty and other products.

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(A4) ALUMINUM CO. OF AMERICA. . 1436
(A5) AMERICAN DISTRICT STEAM CO. ..... 1408
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(A7 BETHLEHEM STEEL CO. ..... 1442
(A8) BETZ, W. H. & L. D. ..... 1419
(A9) BLACK, SIVALLS & BRYSON, INC. ..... 1312
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# WHAT'S NEW!

**Equipment**
**Materials**
**Processes**
**Literature**

*Reviewed by WILLIAM C. UHL, Equipment Editor*

## Work Stand Eases Maintenance, Repairs on Diesel Engine Heads

Greater convenience is claimed as a feature of the new "All-Kleer" Diesel Engine Stand, designed for use in service shops. The stand engages the Diesel heads from the side and does not block cleaning or other work on the manifold ends. The head is grasped firmly in a nonjiggling grip by four adjustable engaging pins that fit into the head bolt holes and lock into place. Loosening or tightening the pressure brake permits rotation of the engine head to practically any angle. A sub-assembly adapter is available to fit the All-Kleer, permitting the operator to service also small Diesel assemblies such as governors, fuel pumps, and similar items. Other accessories include heavy-duty rollers that permit moving the fully-loaded engine stand anywhere in the shop, a removable oil drip pan of approximately 10 gal. capacity, and a tool pan. The entire stand measures 34 in. high, 30 in. wide, and 33 in. long. It will handle heads or accessories weighing up to 800 lbs. Interchangeable engaging pins enable the unit to handle nearly all makes of Diesel heads. R & G Mfg. Co., 504 Wysor Bldg., Muncie, Ind.

*Circle No.* **1** *on Reply Card*

### For More Information

Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage required.

## Air-powered Portable Elevator Safe in Hazardous Atmospheres

Designed for operation in dusty and explosive vapor areas, the new Barrett air-operated portable elevator is powered by an Ingersoll-Rand air motor hoist, operating from a compressor. Required air pressure is 80 psi, and consumption is approximately 2.5 cu. ft. per minute per foot of lift. The elevator includes an automatic brake which holds the load, an automatic "up-stop" that shuts off the air motor just before the platform reaches the top position, a safety downstop for holding the platform at the low level, a graduated reversing valve for control at all positions, and a poppet throttle valve to prevent air leakage when the hoist is idle. The compact, radial motor has renewable and interchangeable cylinders and includes automatic lubrication. Elevators are available in lifting capacities up to 2000 lb. Barrett-Cravens Co., 4609 So. Western Blvd., Chicago 9, Ill.

*Circle No.* **2** *on Reply Card*

## Pneumatic Actuator Is Designed For Non-lubricated Plug Valves

An air or hydraulic cylinder actuator has been developed for the Wedgeplug dry plug (non-lubricated) valve. The mechanism consists of two opposed cylinders driving a rack. This rack engages the regular cam-tracked rotating member on the spindle of the valve and drives it through the sequence of lifting the plug, rotating it 90° and reseating. The positioner can be readily adapted to remote control and the speed of operation can be set by the size of the exhaust orifice. Smooth, uniform operation in about two seconds is accomplished without objectionable hammer blow action. Manual operation is available with the handwheel. Because of its compact design, the cylinder operator adds very little additional weight to the valve assembly. The operator can be designed for various sizes in the manufacturer's line. Wedgeplug Valve Co., Inc., 1300 So. Broad Ave., New Orleans 15, La.

*Circle No.* **3** *on Reply Card*

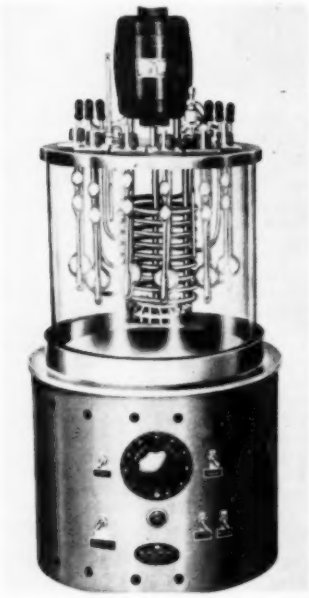
## Stearone and Stearanilide Are Two New Wax-making Materials

Two new development products, useful in wax manufacturing and technology, have been announced by Emery Industries, both available in experimental quantities. Emery C-842-R Stearone is suggested as a wax or as a wax extender. It is a white, crystalline solid, with a melting point of approximately 75° C. It is insoluble in water, and only slightly soluble in hot alcohol or ether. A 35-carbon

atom straight chain ketone, it is represented by the following formula: $CH_3 - (CH_2)_{16} - (CO) - (CH_2)_{16} - CH_3$.

Emery A-805-R Stearanilide also has a wax-like character and compatibility with other waxes, showing promise as a wax or wax extender for polishes, carbon paper, paper coatings, textile auxiliaries, etc. Stearanilide is a hard, odorless, waxy solid with the following formula: $CH_3 - (CH_2)_{16} - (CO) - (NH) - (C_6H_5)$. Typical characteristics are: acid value, 3.0; melting point, 81° C.; hardness (Shore Durometer B), 65; flash point, 480° F.; fire point, 535° F.; color, solid, light tan. At higher temperatures, solubility in solvents increases and upon cooling, its unusual ability to hold large quantities of solvent results in gel formation. Emery Industries, Inc., Dept. 5, Carew Tower, Cincinnati 2, Ohio.

*Circle No.* **4** *on Reply Card*



### Viscosimeter Readings Are Easy, Bath Has Non-turbulent Mixing

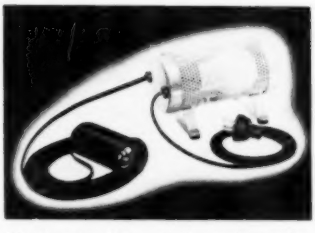
Designed with a new turbine type stirrer, the Kinematic Viscosity Bath is said to provide perfect temperature control and distribution without air entrainment. It is designed for use with capillary viscosimeters. The liquid medium is agitated rapidly and thoroughly without any surface turbulence to mar observations. A new type holder permits free insertion of a tube in the chuck-like grip without any danger of breaking the viscosimeter or injuring the operator. A circular, fluorescent light in the base provides illumination. The base of the glass jar is frosted to eliminate glare and to diffuse light over the entire area. Agitator is powered by an over rated, end thrust, ball bearing Bodine motor. Emil Greiner Co., 20-26 North Moore St., New York 13, N. Y.

*Circle No.* **5** *on Reply Card*

### Insulated Electrical Heating Helps Prevent Pipe Freeze-Ups

"Thermwire" is a new flexible electric heating cable said to be useful, for example, in heating outdoor piping to prevent freezing or keep viscous fluids flowing in cold weather, and similar jobs. The cable consists of a heavy-gage, nickel-chromium resistor wire with an abrasion-resistant insulating sheath. It can also be used to protect roofs, gutters, and downspouts from dangerous and costly accumulations of snow and ice; or it can be imbedded in asphalt or concrete to eliminate ice from drives, walks, etc. in winter weather. Thermwire is being made up in two packaged sets: one is 80 ft. long, 400 watts, 115 volts; the other is 160 ft., 800 watts, 230 volts. Each set has a 10-foot cold lead section and plug. Thermostatic control can be had optionally. Edwin L. Wiegand Co., 7605 Thomas Blvd., Pittsburgh 8, Penna.

*Circle No.* **6** *on Reply Card*



### Water Leak Detector Operates By Ultra Violet Fluorescence

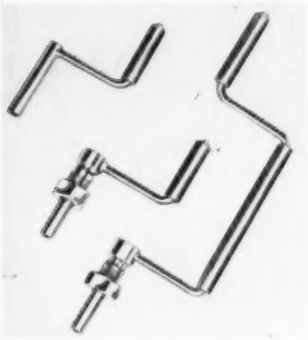
A new detector for minute water leaks is based on the phenomenon that certain materials will fluoresce when activated by ultra-violet light. The Model E-163 Water-Leak Detector provides for safe detection of tiny leaks of water from automobile engine blocks, heads, radiators, or from tanks, boilers, and other water processing units wherever it is possible to add a fluorescing powder to the water used or contained in the unit to be tested. The fluorescing material is non-toxic and non-corrosive and need be used only in very small quantities, the manufacturer states. In use, the material is mixed with the water in the container. The resultant solution will seep through any crack or crevice. By passing the ultra-violet light over the area to be examined, this seepage is easily discovered because of its bright glow. Allen Electric and Equipment Co., 2101 North Pitcher St., Kalamazoo, Mich.

*Circle No.* **7** *on Reply Card*

### Weld Coupling Design Prevents Formation of Damaging Scale

The Tube-Turn "SF" Welding Coupling now makes it possible to eliminate damaging welding scale from piping systems. The coupling consists of two forged halves, as shown in the illustration. The ends of the hubs are prepared for welding to pipe or welding fittings of corresponding sizes. When the two halves of the coupling are brought together, a tongue of one slips into the groove of the other. A circumferential cavity directly beneath the beveled welding area prevents burn-through or the formation of icicles in the interior. The cavity also insulates the interior from the extreme welding heat and prevents scaling. The tongue and groove arrangement makes alignment easier. Because the coupling hubs are relatively short, any scale or protrusions formed by the attachment welds can be reached and removed before the coupling is connected. The coupling can be taken apart when piping is to be disassembled, and can be re-used. SF couplings are available in sizes from $1\frac{1}{4}$ through 12 in., and in carbon steel, stainless steel, aluminum, and other metals and alloys. Tube Turns, Inc., 224 East Broadway, Louisville 1, Ky.

*Circle No.* **8** *on Reply Card*



### "Winder-Upper" Tool Replaces Key for Tedious Chart Winding

Since the invention of grandfather clocks no practical improvement has been made in such a simple tool as a key winder. The discomfort of twisting a key to wind up a clock motor, instrument chart motor, or other spring-wound control instrument can now be eliminated by the use of a new gadget called the "Campbell Winder-Upper." It's made in three types: Type A is a key end and crank; Type B includes a torque chuck with slip-grip arrangement that converts the crank into a combination torque wrench and crank so that the motor cannot be over-wound; Type C is the same as B but is a brace design to prevent wobble. All are chrome-plated and have red Catalin plastic handles. J. A. Campbell Co., 645 East Wardlow Rd., Long Beach 7, Calif.

*Circle No.* **9** *on Reply Card*

### Protective Paint Can Be Applied Directly Over Rusted Surfaces

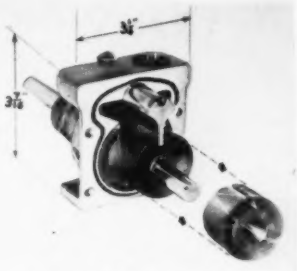
"Rust-Cure" is a new anti-rust paint which can be applied directly over rusted surfaces without wire-brushing, scraping or sand-blasting, it is stated. Suitable for both interior and exterior use on old or new metal, the paint is available in black, aluminum, and clear. It is said to penetrate through any existent rust-layer and seal effectively the surface against further rusting. Normally compounded for brush application, it may be thinned with Rust-Cure solvent for spray use. The black and aluminum products are for use solely as a finish coat; the clear material can be painted over in any color. Packaged in one gallon, five gallon, and 55 gal. containers. The Monroe Co., Inc., 10703 Quebec Ave., Cleveland 6, Ohio.

*Circle No.* **10** *on Reply Card*

### Alkali Resistance Tripled in New Glass for Process Equipment

A new acid-alkali resisting glass is intended for use in the pH range from 9 to 12 and at temperatures up to 212° F. Laboratory tests by the manufacturer indicate that, within this range, the new material has at least three times the alkali resistance of their present glass and about the same acid resistance. It is expected to be useful in processes involving a neutralization reaction, where equipment is subjected to alkaline solutions at moderate temperatures; and also in polymerizers for organic plastics, where the polymerization is often carried out at a pH of 10 to 12 and below 212° F. The Pfaudler Co., 1000 West Ave., Rochester 3, N. Y.

*Circle No.* **11** *on Reply Card*




### Small Capacity Laboratory Pump Made in Teflon Construction

"Allchem" positive displacement pumps are a new line of small—1 to 20 gpm—units for small volume process or laboratory work, featuring Teflon impellers and packed stuffing boxes and a choice of Teflon or Graphitar self-lubricating bearings. They have stainless steel castings and shafts and will operate at pressures up to 40 psi. with high lift. The pump design includes self-priming. Pumps are available in port sizes $\frac{3}{8}$, $\frac{1}{2}$, and $\frac{3}{4}$ in. pipe tap, with pulley drive base assembly or base-mounted direct connected electric motor. Housing may be obtained in No. 316 stainless steel castings or in Naval bronze forgings. Eco Engrg. Co., 12 New York Ave., Newark 1, N. J.

*Circle No.* **12** *on Reply Card*

## DID YOU MISS THESE?

The following items, reviewed originally in the October "What's New!" have aroused considerable interest. They are repeated briefly as a service to those who might have missed them. For details or literature, use the regular reply card in this issue.

### Leaks in Storage Tanks or Pipe Repaired with Rubber Patch

A rubber patch vulcanized in place provides a quick method of repairing leaks in storage tanks and pipe lines. The leak is sealed with a synthetic rubber plug and then coated with a transparent cement. On top is then spread one coat each of three types of adhesive. This is followed by a patch of high-carbon content, uncured rubber about $\frac{3}{8}$ in. thick and finished off with a 20-gauge steel backup plate. The complete patch is given a cure in a special heater to within about 1/16 in. of the tank wall—the uncured portion allowing for expansion and contraction. A sample under test withstood a pressure of 2120 psi. before failure. Vulcan Patch Co., 217 West Lincoln, Montebello, Calif.

*Circle No.* **13** *on Reply Card*

### Removes Destructive Entrainment From Steam and Air Lines

A new receiver-type purifier removes destructive entrainment from vapor lines. Suggested uses are 1) to protect turbines and steam engines from damaging slugs of entrainment, 2) in exhaust steam applications where oil and other undesirable entrainment must be removed, 3) to take out condensate from compressed air systems. In steam service, the unit is guaranteed to purify boiler steam with a concentration of 1000 ppm. Solids to less than 0.5 ppm. In exhaust steam, 99% of the oil is removed, down to less than 2.5 ppm. oil. V. D. Anderson Co., 1935 West 96 St., Cleveland 2, Ohio.

*Circle No.* **14** *on Reply Card*

### What's a Servomechanism?

*Servomechanism Techniques in Modern System Engineering;* a 24-page pocket-size booklet explaining in simplified terms and diagrams, just what the theory of servomechanisms is and how it is being used and can be used to solve process control problems. Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Philadelphia 44, Penna.

*Circle No.* **15** *on Reply Card*

### Esso's New British Refinery

*Heat Engineering*, Sept. 1951, is devoted entirely to a description of the new Fawley refinery of Esso Petroleum Co.; includes general background data on design and construction. Foster Wheeler Corp., 165 Broadway, New York 6, N. Y.

*Circle No.* **16** *on Reply Card*

# Any Way You Want it!

## WARREN'S Stabilized NATURAL GASOLINE and STA-VOL-ENE

Warren's far-flung network of facilities works hand-in-glove to serve its customers at home and abroad. Every method of commercial communication and every agency of freight distribution are synchronized with Warren's sales, executive, production and traffic departments.

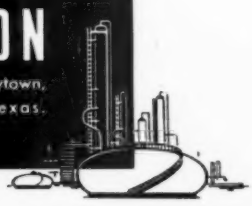
That's why the world's refiners rely upon Warren for Unfailing Quality, Unusual Service and Uniform Delivery of Stabilized Natural Gasoline.

## WARREN PETROLEUM CORPORATION

Producers, Manufacturers, Exporters and Marketers

Export Terminals: Corpus Christi, Port Arthur, Baytown, Texas City, and Norsworthy, Houston, Texas.

TULSA 2, OKLAHOMA CABLE ADDRESSES: Stavolene, Warren



*Crude Oil, Natural Gasoline and Liquefied Petroleum Products*

### Electric Stop Watch Employs Synchronous Motor and Timer

"Lab-Chron" is a new electric stopwatch consisting essentially of a counting unit with built-in reset mechanism and a high torque synchronous motor. It is available in two models; one for 1/10-sec. readings to 9999.9 sec., and the other for 1/100-minute reading to 999.99 min. The case is cast aluminum, finished in a grey baked-on plastic finish and has four rubber feet to protect the table top and to prevent sliding. A panel mounting model is also available. Manufacturer states it is unconditionally guaranteed for one year. Laboratory Industries, Inc., 4710 West North Ave., Chicago 39, Ill.

*Circle No.* **17** *on Reply Card*

## Trade Literature

### Liquid Level by Sound Waves

*Bogue Sonic Liquid Level Indicators;* Bulletin 82; four pages describing a new instrument for measuring level in, for example, oil storage tanks, to within 0.1 in., utilizing the principle of reflecting supersonic waves emanating from the tank bottom up to the liquid surface and return. Bogue Electric Mfg. Co., Paterson 3, N. J.

*Circle No.* **18** *on Reply Card*

### Steam Cost Calculator

*Steam Cost Calculator;* a slide-rule designed for determining costs of operating steam-generating system based on prices of fuels—coal, oil, or gas—and on efficiency of system. Cleaver-Brooks Co., Milwaukee 12, Wisc.

*Circle No.* **19** *on Reply Card*

### Process Control Instruments

*Tel-O-Set Controllers,* Specification Sheet 768; four pages describing pneumatic instruments designed for accurate process control, such as temperature, pressure, flow and liquid level; includes specifications, operational features and general dimensions. Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Wayne and Windrum Aves., Philadelphia 44, Pa.

*Circle No.* **20** *on Reply Card*

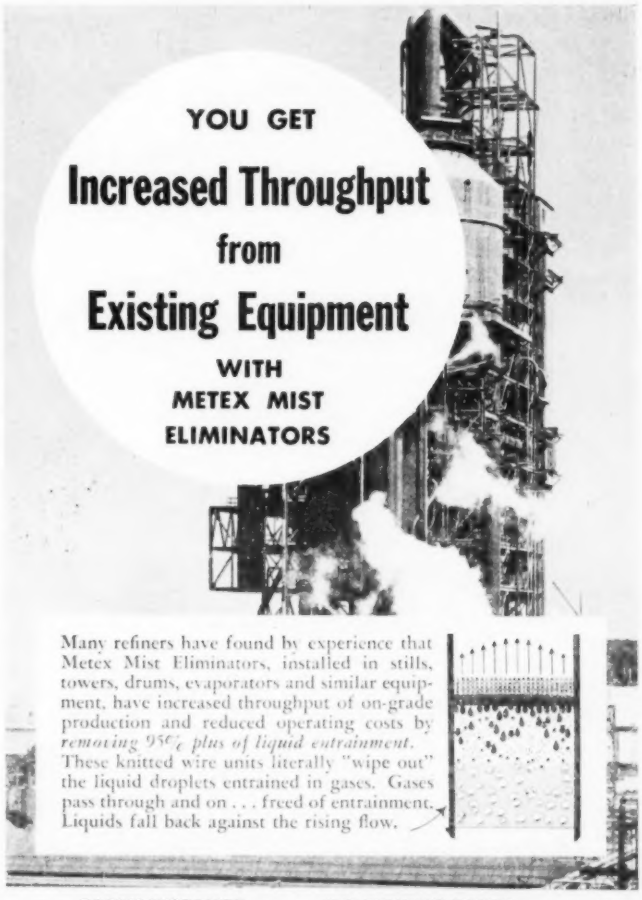
### High Temperature Problems

*High Temperature Work Sheet,* a questionnaire directed to metal users, designed to facilitate inquiries on specific high temperature problems to which answers may be found in company data files covering service records and results of plant and laboratory tests, including nickel, wrought and cast alloys. The International Nickel Co. Inc., Development and Research Div., 67 Wall St., New York 5, N. Y.

*Circle No.* **21** *on Reply Card*

### Vapor Losses Minimized

*Graver Expansion Roof Tanks;* 18-page booklet gives a brief historical account of petroleum conservation equipment, including a newly-devel-



YOU GET
Increased Throughput
from
Existing Equipment
WITH
METEX MIST
ELIMINATORS
Many refiners have found by experience that Metex Mist Eliminators, installed in stills, towers, drums, evaporators and similar equipment, have increased throughput of on-grade production and reduced operating costs by removing 95% plus of liquid entrainment. These knitted wire units literally "wipe out" the liquid droplets entrained in gases. Gases pass through and on . . . freed of entrainment. Liquids fall back against the rising flow.
EASILY INSTALLED
NO MOVING PARTS
Full details on these entrainment separators — sizes, shapes, construction and engineering data — are found in our new 8-page bulletin. Write for your copy today. Just ask for "Metex Mist Eliminators."
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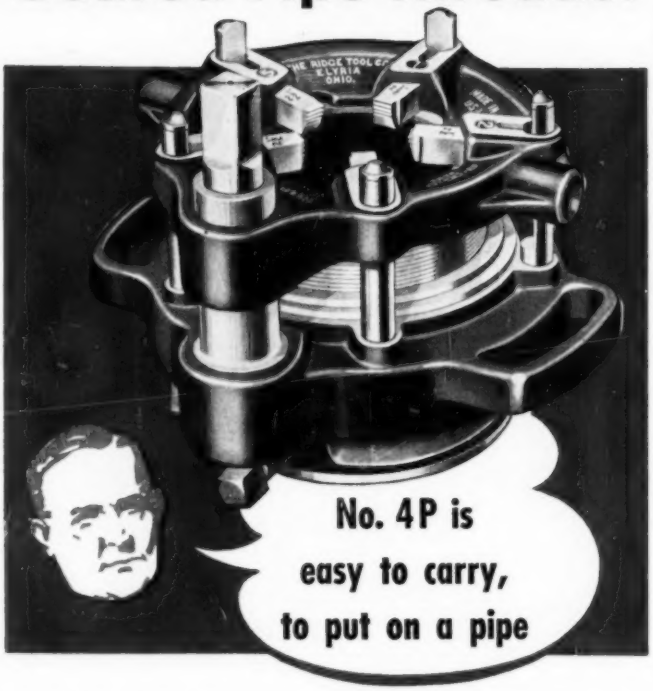
METAL TEXTILE CORPORATION
631 EAST FIRST AVENUE, ROSELLE, N. J.




*(To obtain more data on advertised products see page 1428)*

# Easier to Handle this RIDGID Geared Pipe Threader




● You'll like the balanced loop handles that make it easy to swing the 4P around where you want it. Making it still more of a work-saver, mistake-proof workholder sets to size *before* you put it on pipe—only one screw to tighten, no bushings to fool with. 4 sets of 5 high-speed steel chaser dies give quick, clean threads on 2½", 3", 3½" and 4" pipe. Ratchet handle furnished—for power threading use with RIDGID Universal Drive Shaft and Power Drive. Save your muscles—buy this easier-to-handle RIDGID 4P at your Supply House.

RIDGID

★ Work-Saver Pipe Tools ★


## What's New!

oped center-weighted floating roof, designed to be free to rise or fall in direct proportion to the "breathing" action of the volatile products stored within the tank; including installational tips, standard and special fittings, and a report of technical operating data supplied by Underwriter's Laboratories, Inc. Graver Tank & Mfg. Co. Inc., East Chicago, Ind.

*Circle No.* **22** *on Reply Card*

### Industrial Research Report

*Armour Research Foundation's Annual Report,* 1951; 55-page book illustrates electrical engineering, materials and processes, chemical engineering, metals, and physics projects sponsored by the foundation; organizational chart, administrative personnel and board of trustees included. Armour Research Foundation of Illinois Institute of Technology, 35 W. 33rd St., Chicago, 16, Ill.

*Circle No.* **23** *on Reply Card*

### Industrial Television

*RCA Industrial Television Equipment;* a single-page leaflet and specification sheet explaining the operation and potential applications on cable-type television for industrial uses. Radio Corp. of America, Engrg. Products Dept., Camden, N. J.

*Circle No.* **24** *on Reply Card*

### Distillation Packing, Columns

*Distillation Packing and Columns.* Bulletin 12; 16 pages of technical data, including tables and charts of test data on a new, patented protruded form of laboratory distillation packing, particularly designed for high efficiency columns and close separations; and described recently in an American Chemical Society paper by Prof. M. R. Cannon of Penn State College. Scientific Development Co., Box 795, State College, Panna.

*Circle No.* **25** *on Reply Card*

### Non-Corrosive Pipeline

*The Use of Tenite to Combat Corrosion in Piping Systems,* 30-page book with a brief text on corrosion problems, and characteristics of Tenite tubing, plastic piping for carrying sour crude oil and salt water; charts and 26 full page photographs. Tennessee Eastman Co., Kingsport, Tenn.

*Circle No.* **26** *on Reply Card*

### Spectrometer Has Two Uses

*The New Model* 21-401 *Mass Spectrometer,* Tentative Bulletin 1821; six pages of engineering and technical information on a new combined analytical and isotope ratio mass spectrometer, providing recorded spectra over range of mass 2 to mass 100. Consolidated Engrg. Corp., 300 No. Sierra Madre Villa, Pasadena 8, Calif.

*Circle No.* **27** *on Reply Card*

## What's New!

### Catalyst Losses Checked

*GP Gas Analyzer and Alarm*, ten-page folder; gives an account of a standard unit measuring excess dust in gas, which can be applicable to checking catalyst losses in refinery operations; includes zeroing instructions, calibration chart, itemized list of materials and sample operation charts of the analyzer, picture and drawing. General Power Plant Corp., 381 Fourth Ave., New York 16, N. Y.

*Circle No.* **28** *on Reply Card*

### Steel Fastening Aid

*How to Design for Nelwelding*, Form D-1; eight-page manual on steel stud welding; includes stud specifications and recommended selection guides, suggestions for template design and for accommodating fillet, also a table on minimum stud clearance applicable to the portable Nelson stud welding gun. Nelson Stud Welding Division, Gregory Industries, Inc., Lorain, Ohio.

*Circle No.* **29** *on Reply Card*

### Solvent Extraction

*The Practical Way of Solvent Extraction*, Bulletin No. 12; eight pages describing the use of counter-current, multi-stage, liquid extractors, useful in handling separation of such typical examples as close-boiling, azeotropic, and non-volatile mixtures; materials from dilute solutions; impurities and color bodies; structural isomers; and heat-sensitive materials. Otto H. York Co., Inc., 69 Glenwood Place, East Orange, N. J.

*Circle No.* **30** *on Reply Card*

### Advanced Heating Techniques

*Heat Processing, . . with the most advanced techniques and equipment;* Bulletin No. S-7.1; 12-page booklet discussing the what-why-how of heating, and the application of high-production heating principles to solid and fluid products; illustrated with drawings, pictures and diagrams. Selas Corp. of America, Philadelphia, 34, Pa.

*Circle No.* **31** *on Reply Card*

### Bearing and Shaft Seals

*Garlock Klozures*, Catalog 10; 100 pages describing typical applications of sealing elements, mechanical seals for rotary shafts, installational features and special applications; illustrations, sizes and part numbers. The Garlock Packing Co., Maple Ave., Palmyra, N. Y.

*Circle No.* **32** *on Reply Card*

### Industrial Radioactivity

*Tracerlab*, Catalog C; 107-page catalog of radioactivity scalers and accessories, amplifiers, counting rate and survey meters, Geiger-Mueller tubes and accessories, scintillation


EXTRA — DAILY BULLETIN

# ANOTHER NATIONAL FIRST ★ ★ ★

New AER-O-FOAM "99"

Smothers POLAR SOLVENT Fires

The 5-gallon AER-O-FOAM "99" container is readily identifiable by its distinctive yellow and red label to distinguish it from other types of foam.

AER-O-FOAM "99" . . . new liquid type mechanical foam! Now get positive, quick-acting protection on fires involving polar solvents or petroleum products.

When applied to fires fueled by polar solvents such as methyl, ethyl, isopropyl alcohols, esters, ketones and ethers as well as petroleum products, AER-O-FOAM "99" offers new, dependable, stabilized protection. It is easily generated. Provides smothering, closely-knit blanket of fire-killing foam. Will not readily disintegrate or break down. Thoroughly tested, it is easily applied with existing 6% devices.

**CHECK THESE ADVANTAGES:**

- ✓ Complete protection in automatic systems
- ✓ Simplified storage in tanks
- ✓ Wide choice of application devices

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—Pioneers in the manufacture of foam and foam equipment

NATIONAL FOAM SYSTEM, INC.
Headquarters for Foam Fire Protection
WEST CHESTER, PENNA.

equipment, sample preparation and safety equipment, medical applicators, industrial equipment, radiochemicals, service and repair information; includes specifications, pictures and outstading features. Tracerlab, Inc., 130 High St., Boston 10, Mass.

*Circle No.* **33** *on Reply Card*

### New Method of Lead-Cladding

*The History and Development of Ferrolum Lead Clad Steel and Cupralum Lead Clad Copper;* 24 pages describing a new technique for successful, automatic cladding of lead to steel or copper, as a solution to corrosion problems, particularly in the handling of sulfuric acid or radioactive materials. Knapp Mills, Inc., 23-15 Borden Ave., Long Island City 1, N. Y.

*Circle No.* **34** *on Reply Card*

### Jet Pump Operation

*Penberthy Jet Pumps (Ejectors, Eductors, Exhausters, Syphons);* Bulletin No. 512; includes 20 pages, on the principles of jet pump operation, together with installation and maintenance tips, special jet pumps and the representative uses of the pumps; tables, diagrams and pictures included. Penberthy Injector Co., 1242 Holden Ave., Detroit 2, Mich.

*Circle No.* **35** *on Reply Card*

### Gas Scrubber Functions

*To Clean, Cool, or Absorb Gases. . . Specify Peabody,* Bulletin 203-B; six-page folder describing scrubbing operations of gas coolers and absorbers, with technical data concerning capacities, construction, water consumption, draft loss, maintenance and power consumption; illustrated. Peabody Engineering Corp., 580 Fifth Ave., New York 19, N. Y.

*Circle No.* **36** *on Reply Card*

### Tube Expanders

*Wiedeke Ideal Tube Expanders,* Bulletin No. 71; four-page folder describing ball-bearing tube expanders with adjustable thrust collar; includes instructions on "how to order" and prices. The Gustav Wiedeke Co., Dayton 1, Ohio.

*Circle No.* **37** *on Reply Card*

### Hydraulic Fluid Performance

*Skydrol;* 20-page booklet describes properties of nonflammable, synthetic, hydraulic fluid for aircraft, including latest data on evaluation in the laboratory and performance in aircraft installations. Monsanto Chemical Co., St. Louis 4, Mo.

*Circle No.* **38** *on Reply Card*

### Heavy Duty Compressors

*Clark Balanced Opposed Motor Driven Compressors,* Bulletin No. 118; 50-page catalog, describes the 8, 14, and 17-in. stroke of the various motor driven compressors from the 400-600 BHP range, such as in refinery and chemical plants, to the 1500-4500 BHP units in large industrial plants; specifications, dimensions, and illustrated longitudinal and transverse cross sections included. Clark Bros. Co., Inc., Olean, N. Y.

*Circle No.* **39** *on Reply Card*

ALCOA ALUMINUM TUBE
"Figure it per foot"
EASY TO FORM
EASY TO FLARE
EASY TO HANDLE
When you figure the cost of a tubing installation—figure it per foot. You'll find Alcoa Tube will save 40% over the price of other corrossion-resistant tube. In use you'll find Alcoa Tube an excellent performer—strong, light and highly resistant to corrosion.
Look under "aluminum" in your classified telephone directory—call your Alcoa Distributor.
Due to rearmament, aluminum is not available for unrestricted industrial use. However, when a tubing installation is considered, extensive engineering and planning are required. This advertisement is intended as an aid to your planning.
Aluminum fittings are made by nationally known manufacturers
Free Write for Illustrated Book
Get Alcoa's new booklet, "Instrument Lines of Alcoa Aluminum". Illustrated and crammed with facts. ALUMINUM COMPANY OF AMERICA, 840M Gulf Bldg., Pittsburgh 19, Pennsylvania.
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### For Your Convenience

Business reply cards are included in each issue of PETROLEUM PROCESSING to assist you in obtaining more information on any items reviewed in "What's New!" You'll find them facing the first page of this section. Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the bottom of the card and drop it in the mail. No postage required.

FOR 90° THREADED CONNECTIONS IN ALL HIGH AND LOW PRESSURE PIPING SYSTEMS . . .

specify and use

# BONNEY THREDOLETS

## YOU DERIVE THE FOLLOWING ADVANTAGES:

**1. ACCELERATED FABRICATION—**
with ThredOlets no coupling preparation is necessary—you obtain the most economical type of construction.

**2. NEAT AND UNIFORM APPEARANCE—**
ThredOlets minimize variations caused by human element—you attain the best engineered type of construction.

**3. IMPROVED FLOW—**
ThredOlets provide a funnelled inlet—you achieve better performance and better piping system design.

**4. DIMENSIONAL STANDARDIZATION—**
with each ThredOlet installation, you have constant control of the critical center-of-run-pipe to face-of-outlet dimension.

***The Bonney WeldOlet Welding Fittings Catalog, No. W-3, provides complete engineering and dimensional data.***
*Write for your free copy.*

**WELDING FITTINGS DIVISION**

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*(To obtain more data on advertised products see page 1428)*

# GLIDDOL
## by Glidden

THE *Proved* ADDITIVE MADE TO PRESCRIPTION STANDARDS BY THE...

*Pacemaker in Soya Research*

From the first shipment, Gliddol has been made under rigid laboratory control to prescription standards. Here is the finest soybean additive that can be used to improve the performance of lube oil, fuel oil, grease or gasoline.

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*Everywhere on/in Everything*

ENTRAINMENT SEPARATORS
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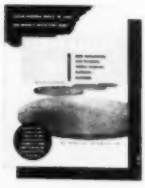
SOLVENT EXTRACTORS

FOR BETTER PROCESSING READ THESE TWO BOOKS



No. 11—ENTRAINMENT SEPARATION and MIST ELIMINATION in all equipment handling liquid and gas phase materials.

No. 12—SOLVENT EXTRACTION applications and equipment description for simplifying difficult separations.

For bulletins and other information WRITE, WIRE OR PHONE

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In Houston, Tex. — The Rainey Co.
In Los Angeles — Jacobs Eng. Co.


## What's New!

### Recording-controlling Viscometer

*Norcross Viscometers*, Bulletin No. V; eight pages of technical data on automatic recording and recording-controlling viscometers suggested for for a wide variety of applications, including petroleum, chemicals, synthetics, etc. Norcross Corp., Newton 58, Mass.

*Circle No.* **40** *on Reply Card*

## Literature Offered in this Issue's Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature offered in this issue:

ADDITIVES, for cutting oils: Information on Santolube 52 offered by Monsanto Chemical Co. See adv't p. 1321.

ADDITIVES, for greases: Samples of "Ortholeum" 300 and Phenyl-alpha-naphthylamine offered by Dupont. See adv't p. 1406.

ALLOYS, nickel-base: Booklet offered by Haynes Stellite Co. See adv't p. 1349.

CATALYST, cracking: Details offered by National Aluminate Corp. See adv't p. 1354.

CATALYST SUPPORTS: Samples offered by the Norton Co. See adv't p. 1339.

CATALYSTS, synthetic, fluid-type, cracking: Descriptive information offered by The Davison Chemical Corp. See adv't pp. 1358-1359.

CHEMICALS: General Products List 100 and Technical Data Sheets offered by Hooker Electrochemical Co. See adv't p. 1313.

CLEANING & DESCALING heat exchangers. Booklet offered by Oakite Products, Inc. See adv't p. 1417.

CONTAINERS, sampling, pressure-type: Folder PP-12 offered by Hoke Inc. See adv't p. 1409.

CONTROL SYSTEMS: Bulletin 98151 offered by Taylor Instrument Companies. See adv't pp. 1330-1331.

CONTROL SYSTEMS: Details offered by The Foxboro Co. See adv't p. 1348.

COOLING TOWERS: Bulletins offered by J. F. Pritchard & Co. See adv't p. 1401.

CYCLOVERSION, and other processes: Full information offered by Phillips Petroleum Co. See adv't p. 1323.

ENGINEERING SERVICES: Descriptive literature offered by General Industrial Development Corp. See adv't p. 1324.

EXPANSION JOINTS: Bulletin No. P-35-15 offered by American District Steam Co., Inc. See adv't p. 1408.

FIRE-PROTECTION, liquid-type mechanical foam: Details offered by National Foam System, Inc. See adv't p. 1435.

FLOATING ROOFS: Bulletin offered by General American Transportation Corp. See adv't p. 1310.

HEAT EXCHANGERS: Bulletin offered by The Griscom-Russell Co. See adv't p. 1346-1347.

HEAT EXCHANGERS, sectional hairpin: Bulletin No. 481 offered by The Brown Fintube Co. See adv't p. 1334.

INERT GAS GENERATORS: Details offered by Roots-Connersville Blower Corp. See adv't p. 1412.

LIQUID LEVEL CONTROL: Catalog 103 offered by Black, Sivalls & Bryson, Inc. See adv't p. 1312.

LIQUID LEVEL GAGES: Catalog 35 offered by Penberthy Injector Co. See adv't p. 1328.

LIQUID LEVEL GAGES: New 8-page catalog offered by Jerguson Gage & Valve Co. See adv't p. 1404.

MIST ELIMINATORS: 8-page bulletin offered by the Metal Textile Corp. See adv't p. 1433.

MIXERS, vertical, top-entering: Catalog No. 600 offered by Eastern Industries, Inc. See adv't p. 1411.

OXYGEN RECORDER: Comparison graph and Bulletin 50-8Z9 offered by The Hays Corp. See adv't p. 1322.

PAINT, rust-preventive: Catalog offered by Rust-Oleum Corp. See adv't p. 1443.

PAINT, for storage tanks: Data offered by The Sherwin-Williams Co. See adv't p. 1336.

PIPE FITTINGS, welded: Catalog No. W-3 offered by Bonney Forge & Tool Works. See adv't p. 1437.

PUMPS, acid: Bulletin No. 152 offered by Instruments, Inc. See adv't p. 1441.

PUMPS, eyeling jet: Bulletin 5030 offered by Penberthy Injector Co. See adv't p. 1328.

PUMPS, ejector: Bulletin 512 offered by Penberthy Injector Co. See adv't p. 1328.

SCALES, automatic, for weighing additives: Bulletins offered by Proportioneers, Inc. See adv't inside front cover.

SHAFT SEALS: Bulletin 174PP offered by the Durametallic Corp. See adv't p. 1411.

SPECTROMETERS, mass, analytical and isotope-ratio combined: Bulletin CEC-1821-X4 offered by Consolidated Engineering Corp. See adv't p. 1422.

STEAM TRAPS: Catalog No. 68-Q offered by Strong, Carlisle and Hammond Co. See adv't p. 1398.

STEAM TRAPS, freeze proof: Bulletin 450 offered by W. H. Nicholson & Co. See adv't p. 1409.

SULFUR, by gas processing: Bulletin offered by The Girdler Corp. See adv't p. 1355.

TELEVISION, wired, industrial: Bulletin 1025 offered by Diamond Power Specialty Corp. See adv't p. 1335.

TUBE FITTINGS: Catalog B-151 offered by the Crawford Fitting Co. See adv't p. 1400.

TUBES, heat exchanger: 24-page booklet offered by Aluminum Co. of America. See adv't p. 1414.

TUBING, aluminum: Booklet entitled "Instrument Lines of Alcoa Aluminum" offered by Aluminum Co. of America. See adv't p. 1436.

TUBING, heat exchanger: Bulletin offered by Wolverine Tube Division. See adv't p. 1420.

VALVES, control: Bulletin 700-3 offered by Minneapolis-Honeywell Regulator Co. See adv't p. 1399.

VALVES, control: Bulletin 750 entitled "Control Valve Sizing Data", offered by Minneapolis-Honeywell Reguator Co. See adv't p. 1399.

VALVES, lubricated plug, steel and alloys: Illustrated catalog offered by H. K. Porter Co., Inc. See adv't p. 1314.

VALVE OPERATOR: Bulletin C-1 offered by Conoflow Corp. See adv't p. 1441.

WAX CRYSTALLIZER, continuous: A PETROLEUM PROCESSING reprint offered by Welding Engineers, Inc. See adv't p. 1410.

# API Cites Three for Safety Work

J. C. Bernd

C. E. Townsend

R. S. Bonsib

Cited with "Certificates of Appreciation" by the safety committee of the American Petroleum Institute's Board of Directors last month, for services to the oil industry's safety program, were: **Joseph C. Bernd,** Sinclair Refining Co.; **C. Elmer Townsend,** Sun Oil Co.; and **Roy S. Bonsib,** Standard Oil Co. (N. J.). All are now retired.

Mr. Bernd started with Sinclair in 1919 as chief draftsman of the shops department at the East Chicago refinery. In 1922 he became actively associated with the Petroleum Section of the National Safety Council. He served as chairman of the Great Lakes Division, Petroleum Section of the National Safety Council for several years. He was one of the chief figures in establishing the API Department of Accident Prevention. During World War II, Mr. Bernd served as a member of the Petroleum Industry War Council, and was district representative of the U. S. Department of Labor for Conservation of Manpower in War Industries. He contributed to the preparation of API accident-prevention manuals.

Mr. Townsend joined Sun Oil Co. in 1917 in the insurance department, and in 1928 became active in API's fire-protection activities. He served for 12½ years as chairman of the Committee of Fire Prevention in Refineries. He contributed much to engineering design for fire protection in refineries and to publications of the Institute dealing with fire protection.

Mr. Bonsib became chief safety inspector for the Standard Oil Co. (N. J.) in 1920 and a year later was made safety director. During his safety work with Jersey Standard, he devoted his efforts to problems of toxicity, as well as the mechanical aspects of safety. In 1946 he was appointed industrial hygienist. His efforts were greatly instrumental in the establishment of the Medical Advisory Committee for the API which led to consideration of broader aspects of health and hygiene in the petroleum industry.

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Dr. Fieldner

**Dr. Arno C. Fieldner,** chief fuels technologist of the Bureau of Mines, received an honor award November 28th from the Washington, D. C. Society of Engineers, in recognition of outstanding professional achievement. Although in existence for many years, this award has been presented only four times previously. Dr. Fieldner received his degree from Ohio State University and joined the Technologic Branch of the Geological Survey in 1907 as a chemist. He joined the Bureau in 1910.

* * *

**Dr. Warren F. Faragher,** technical advisor to the vice president for research and development of Houdry Process Corp., Philadelphia, was one of 12 industrialists to receive an award last month from the Department of the Army, for investigations and contributions to the World War II effort in the field of industrial intelligence. In a special ceremony in Franklin Hall at Franklin Institute, Dr. Faragher was presented a certificate in recognition of his services as an investigator of the German fuels and lubricants industry near the end of the last war. At that time he was a member of the field investigation staff of the Technical Industrial Intelligence Committee, sent to Germany by PAW in 1945, which worked closely with the Joint Chiefs of Staff.

* * *

Mr. Parker

**Howard A. Parker, Jr.,** formerly of the research department of the Standard Oil Co. (Indiana) has been named technical director of Pan-Am Southern Corp.'s Destrehan, La., refinery. Mr. Parker holds B.S. and M.S. degrees from Cornell University. He joined Indiana Standard in 1944 as a process design engineer, and in 1946 was made group leader in charge of process design.

* * *

New officers of the National Lubricating Grease Institute for 1952 are: **George E. Merkle,** Fiske Brothers Refining Co., president; **Wayne W. Albright,** Standard Oil Co. (Indiana), vice president; and **C. B. Karns,** Esso Standard Oil Co., treasurer.

Members of the Institute's Board of Directors, elected at the annual meeting in Chicago, include: **M. R. Bower,** Standard Oil Co. (Ohio); **A. J. Daniel,** Battenfeld Grease & Oil Corp.; **F. E. Rosenstiehl,** The Texas Co.; **G. A. Olsen,** Sunland Refining Corp.; **W. H. Saunders, Jr.,** International Lubricants, Inc.; and **B. G. Symon,** Shell Oil Co.

* * *

**Donald A. Voorhees,** industrial engineer at General Petroleum's Torrance, Cal., refinery, has been selected president of the Los Angeles chapter, Society for Advancement of Management.

* * *

**Reginald J. S. Pigott,** director of the engineering division of Gulf Research & Development Co., Pittsburgh, has been elected president of the American Society of Mechanical Engineers for 1952. He has been director of engineering research for Gulf since 1929.

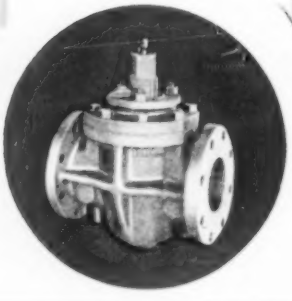
Mr. Pigott

Mr. Pigott was born in Wellington, Shropshire, England, and received his mechanical engineering degree from Columbia University in 1906. He was awarded the university's Medal for Excellence in 1946.

He is a past president of the Society of Automotive Engineers, and was the first president of the Amer-

# The Invisible Feature

## THAT PREVENTS VALVE LEAKAGE



***The ports are surrounded by an impassable barrier of pressurized lubricant***

You can't see what's going on inside of a valve when you operate it. But you want to know with certainty that you have a complete, positive closure. If a valve seat is exposed to the line or you have to guess if discs are tightly seated you can't be absolutely sure of a leakproof shut-off. But in any Nordstrom valve, the seat is *never exposed*. Rotation of the plug a quarter turn slides the plug ports shut. A pressurized seal of lubricant surrounds each port to prevent leakage. *Keep upkeep down.*

# Nordstrom Valves

— NOW AUTOMATICALLY LUBRICATED WITH Hypermatic

**ROCKWELL MANUFACTURING COMPANY** 400 North Lexington Avenue, Pittsburgh 8, Pennsylvania

Atlanta, Boston, Chicago, Columbus, Houston, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco, Seattle, Tulsa . . . and leading Supply Houses.
Export: International Division, Rockwell Manufacturing Company, 7701 Empire State Building, New York 1, N. Y.

## Personals

ican Society for Measurement and Control, now the Pittsburgh Chapter of the Instrument Society of America. Mr. Pigott was president of ISA in 1950.

* * *

**R. T. Agster** has been named manager of the Petroleum Department of United Co-Operatives, Inc., Alliance, Ohio, succeeding **R. P. Howe** who has been transferred to Little Rock, Ark., as manager of that field office.

**Mr. Agster**

Mr. Agster is a petroleum engineer, graduating from the Petroleum Engineering Department of Penn State College. He spent one year with Sinclair Refining Co. as a lubrication engineer, seven years with the Phillips Petroleum Co. as technical assistant to the director of research and chief of the high test section. Later he spent five years with the Standard Oil Co. of Calif. as product engineer, automotive and aviation fuels and lubricants.

* * *

Promotions at the Bayonne refinery of the Tide Water Associated Oil Co., include: **Henry Schiffbauer,** to zone supervisor of the mechanical department; **George S. Jeffers** to general foreman of the machine shop; **Herman C. Osbahr** to foreman of the paint shop.

**Joseph M. Yurko** to general foreman of the rigger department; **Lawrence B. Buther** to zone 3 supervisor; and **William J. Dennison** also to zone 3 supervisor.

* * *

Shell Chemical Corp.'s recent personnel changes:

**Frank D. Kuenzly,** from superintendent of the Shell Point plant, Pittsburg, Cal., to plant manager of the new ammonia plant to be built at Ventura, Cal., temporarily assigned to New York to assist in the preliminary planning; **Ernest W. Casagrande,** from assistant superintendent of the Dominguez plant to superintendent at Shell Point, succeeding Mr. Kuenzly.

**R. L. Kittle,** from plant superintendent at Torrance to assistant plant superintendent at Dominguez; **W. O. Geren,** from operation department manager at Torrance to assistant plant superintendent of the Ventura ammonia plant; **Glenn Purcell,** from assistant plant superintendent at Houston, to plant superintendent; **H. G. Duguid,** from chief engineer at Houston to plant superintendent at Torrance.

**F. G. Watson,** from operations department manager, Houston, to assistant plant manager; **R. K. Walters,** from assistant chief engineer to chief


NEW! GEAR-DRIVEN PNEUMATIC OPERATOR FOR THROTTLING CONTROL SERVICE

Rotomotor

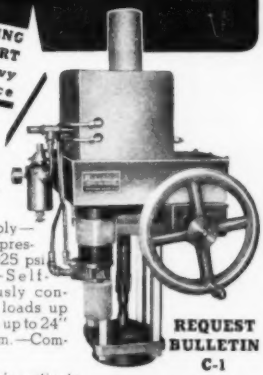
PNEUMATIC POWER POSITIONING OPERATOR

ACCURATE POSITIONING TO WITHIN 1/500th PART of STEM TRAVEL on Heavy Duty Throttling Service

A wholly new and different valve operator employing a reversible pneumatic motor and a precision gear driven screw stem, with these AMAZING advantages:

Operates on 100 psi supply—Sensitivity to instrument pressure changes as small as .025 psi—Perfect stability—Self-locking stem—Continuously connected handwheel—Stem loads up to 40,000 lbs.—Stem travels up to 24" Stem speeds up to 36" p.m.—Compact design.

So different, you will want to investigate its possibilities immediately.



REQUEST BULLETIN C-1

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for displacement meters. Any capacity — Any Specification.

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COALESCERS
remove all free water from products streams prior to dessicant dehydration.

EXCEL-SO
SEPARATORS
Coalesce and remove all free water from light petroleum products.

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NEW ACID PUMP
No Working Parts!

New Merc-O-Pump gives constant, positive action employing a column of mercury as the liquid mover. Cuts operating costs and downtime. Air or steam operated. Rate: 3 gallons to 30 gallons per hour. Rate variable over entire range by external adjustment. Low initial cost.

Write for Illustrated Bulletin No. 152

INSTRUMENTS, INC.
122 N. Madison Tulsa 6, Okla.

# You don't have to baby this assembly

That's right! When you use the Bethlehem Continuous-Thread Stud, together with Bethlehem Quenched Nuts, you've got an assembly that will stand up in high-temperature, high-pressure bolting applications.

The Bethlehem Continuous-Thread Stud gives a good account of itself in difficult bolting jobs because it minimizes stress concentrations. The stud has no point of thread runout; consequently stresses can't concentrate at any one point. Instead they are distributed over the full working length of the stud.

And the Bethlehem Quenched Nut is economical because of its built-in strength. It is unlike common nuts because it is made from a 40 to 50 Carbon quality steel by forging and extruding hot metal into a forming die. This procedure, followed by quenching and tempering, arms the Quenched Nut with sufficient strength to break the stud or bolt on which it is used.

The Bethlehem Continuous-Thread Stud and Quenched Nut come in a wide range of sizes. Any way you look at it, they form an economical, long-lasting assembly that will do a good job for you.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

*On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation*

BETHLEHEM STEEL

## Bethlehem supplies every type of Fastener

## Personals

engineer at Houston; **H. E. Hughes,** from chief engineer at Dominguez to assistant chief engineer, Houston; **J. E. Mital,** from senior technologist at Houston to chief technologist at Shell Point; **Dave Luckenbill,** from assistant to plant manager at Shell Point to senior technologist, manufacturing department development and headquartered in New York.

* * *

**H. F. Glair,** general manager of manufacturing with the Standard Oil Co. (Indiana) since 1933, was recently appointed director of purchases, a new position.

**S. A. Montgomery,** assistant general manger of manufacturing, has been advanced to general manager of manufacturing, and **Dr. W. J. McGill,** superintendent of manufacturing operations, to assistant general manager. **Dr. R. C. Gunness** also will become an assistant general manager in the manufacturing department, effective January 1. Dr. Gunness, general manager of the research department, is presently on leave serving with the defense department in Washington.

**J. H. Forrester,** currently manager of the Central Division of the Stanolind Oil and Gas Co., subsidiary of Standard, has been named manager of research, filling the vacancy created by the promotion of Dr. Gunness. Mr. Forrester has held various positions in the research department of the Standard Oil Co. since 1929, and was associate director of research and director of technical service at the time of his transfer to Stanolind in 1946.

* * *

**Osgood V. Tracy,** on leave as general manager of the Chemical Products Department of Esso Standard Oil Co., has been appointed Director of NPA's Chemical Division. He joined NPA a month ago as Deputy Director of the Chemical Division.

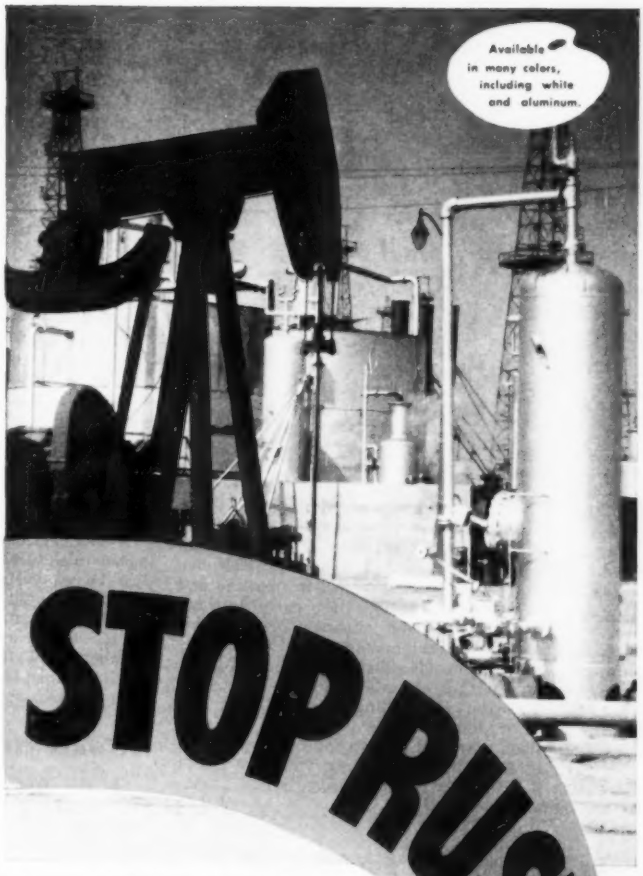
**Kenneth H. Klipstein,** former Director of the Chemical Division, has been named Assistant Administrator to head the Chemical, Rubber and Forest Products Bureau of NPA

* * *

**Clarence B. Round** has been promoted to the newly-created position of assistant to **Harold G. Osborn,** vice president in charge of manufacturing for Continental Oil Co., Ponca City, Okla.

**I. A. Harrisberger,** chief manufacturing clerk since 1937, succeeds Mr. Round as coordinator of manufacturing operations at Ponca City.

Mr. Round, a native of Ponca City, joined the company in 1929 following his graduation from the University of Oklahoma. Mr. Harrisberger, originally from Winkler, Kans., and located in Ponca City for the past 15 years, joined Continental in 1922 as a clerk in a refinery operated by the company at Florence, Colo.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# EDITORIAL VIEWPOINTS

**Opinions and Comments on Current Topics**

## *Lets Get in the Steel Scrap!*

BEING sixth among industries in the national consumption of steel, the oil industry may have more than a patriotic reason in lending stronger efforts to the drive to get scrap into the mills. Late in November the United States Steel plants in the Pittsburgh area were reported producing 3% less steel than they could if the scrap situation were satisfactory. It might be that some of the steel a refiner will not get, or will be delayed in receiving, will be steel not made because the scrap bins at the mills were temporarily empty.

"Scrap is where scrap has been sold", W. T. Hoyt, executive secretary of the Steel-Industry Scrap Mobilization Committee, told the API at Chicago last month. Refiners have a good deal of what the steel people call "plus tonnage", the steel in obsolete and dormant equipment which does not move through the regular scrap collection channels. Before this scrap can be moved, plant management has to come into the picture to decide whether present obsolete items may have further life either in place or relocated, what effect the dismantling and scrapping will have on taxes, or plant housekeeping.

An extra push now in the scrap collection program, from the top down in the refinery, will help offset the winter slowdown in receipts which is now pinching the mills. —V.B.G.

## *Light on Synthetic Fuel Costs*

SECRETARY of the Interior Chapman has made a sound move in calling on a qualified agency entirely outside the oil industry to review the Bureau of Mines data on the costs of establishing commercial coal hydrogenation plants. His selection of an engineering firm to do this work also has general approval. Ebasco Services Inc., a service subsidiary of Electric Bond & Share Co., in the scope of its operations ranks with the large engineering firms of the country. Its experience includes work in natural gas and oil production and in coal utilization.

The chief remaining point to be settled in the arrangement of Secretary Chapman with Ebasco Services is to establish the premise on which the costs of coal hydrogenation are to be set up. The important differences between the costs as set up by the oil companies and by the Bureau stem from differences as to what is required to attract investment capital to such an enterprise. Such capital costs as interest on borrowed money, and rate of return on private capital, as estimated by the National Petroleum Council's committee assigned this task, are on a basis believed necessary to induce private capital to invest in a new enterprise with recognized risks. Also the cost of private capital for the construction of offsite facilities are included.

On the other hand, the Bureau of Mines, in its Oct. 25th cost report, does not regard the manufacture of motor fuel and other liquid products from coal hydrogenation as entailing any undue risks for funds so invested. The Bureau believes a majority of the capital required can be borrowed money, secured at 3.5% rate of interest, and that only a minor proportion of equity capital will be necessary. It also takes the position that civic organizations and other non-profit agencies can be interested in financing employes' homes and other offsite facilities.

Many oil men believe that financing costs of this order would require paternalistic support through some form of government subsidy. The current proposal of Secretary Chapman to take $100,000,000 in federal funds to help launch a commercial coal hydrogenation plant supports this view. Such costs are misleading if they are presented as typical for a large synthetic fuel industry which in the main must be built and supported by private capital.

If the coming audit of the Bureau of Mines estimates serves only to establish a sound basis for estimating capital costs required for commercial synthetic fuel plants it will make a definite contribution to future consideration of such projects.—V.B.G.

## *Wildcatting in Domain of Science*

THE development work which Phillips Petroleum Co. has done in synthetic rubber is fittingly recognized through its receiving the 1951 plaque of a group of leading scientists of the nation who make up the Committee of Award for Chemical Engineering Achievement. This tribute resulted from its pioneering development of high abrasion furnace black and from its major contribution to the cold rubber program.

Back of this important achievement by the Phillips company is a general research program going back more than 25 years, supported by Frank Phillips who started the company and was long its head. Mr. Phillips had no scientific training, in fact little general schooling by today's standards. He came to be a prominent figure in the oil industry through starting as a wildcatter. His company was among the first, however, to appreciate the importance that research was destined to play in making efficient use of our petroleum resources. In Bartlesville, not far from the site of the first oil wells in Oklahoma, his scientific staff in the early 20's built a petroleum research laboratory which is today one of the important oil research centers of the country.

In being one of the first oil companies to build a research laboratory, Frank Phillips and his staff were pioneering in the domain of science in the same manner he operated in his search for oil—making a venture against uncertain and perhaps risky returns. The award to the Phillips company of the 1951 honor for chemical engineering achievement demonstrates that this particular wildcatting venture has paid off, for the public and the company. —V.B.G.

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Potassium Fluoborate
Sodium Fluoborate

### ALKALI FLUORIDES
Ammonium Fluoride
Potassium Fluoride
Sodium Fluoride

### DOUBLE FLUORIDES
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Potassium Chromium Fluoride
Potassium Ferric Fluoride
Potassium Titanium Fluoride
Potassium Zirconium Fluoride

### METAL FLUORIDES
Aluminum Fluoride, Crystal
Antimony Trifluoride
Antimony Pentafluoride
Barium Fluoride
Cadmium Fluoride
Calcium Fluoride
Chromium Fluoride
Cobalt Trifluoride
Copper Fluoride
Ferric Fluoride
Lead Fluoride
Magnesium Fluoride
Molybdenum Hexafluoride
Nickel Fluoride
Strontium Fluoride
Titanium Tetrafluoride
Tungsten Hexafluoride
Zinc Fluoride
Zirconium Tetrafluoride

### METAL FLUOBORATE SOLUTIONS
Cadmium Fluoborate
Chromium Fluoborate
Cobalt Fluoborate
Copper Fluoborate
Ferrous Fluoborate
Indium Fluoborate
Lead Fluoborate
Nickel Fluoborate
Silver Fluoborate
Stannous (Tin) Fluoborate

### NON-METAL FLUORIDES
Boron Fluoride Gas
Boron Fluoride—Diethyl Ether Complex
Boron Fluoride—Phenol Complex
Boron Fluoride—Other Complexes
Sulfur Hexafluoride

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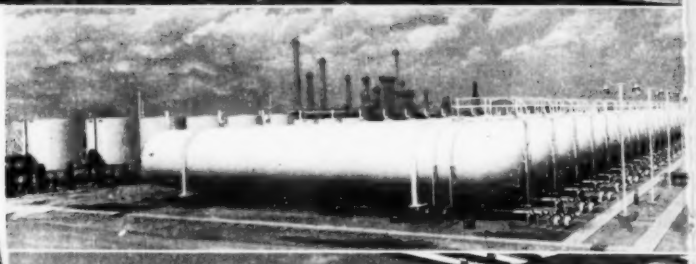
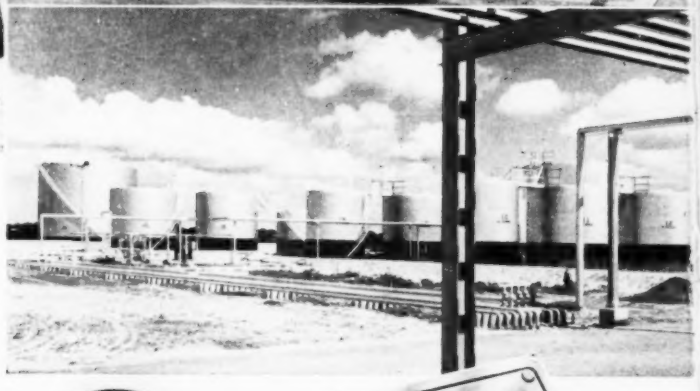
*The products listed include those which are commercially available as well as a few presently produced only in experimental quantities. For further information on any of these, or on other fluorine compounds you may require, consult the General Chemical Product Development Department.





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